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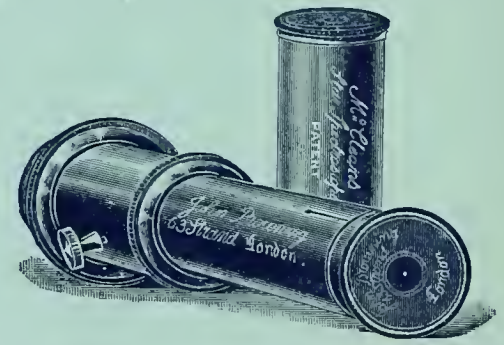

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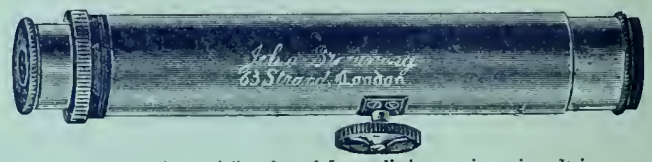

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By SOMERVILLE HASTINGS, M.S., F.R.C.S.

In the following pages an attempt will be made to describe simply some of the more interesting points regarding the life-history of the larger British Fungi. As is the case with most living things, a large proportion of the energy of nearly all the members of the mushroom tribe is given up to the perpetuation of their kind. Therefore, in the description of the life-history of mushrooms and toadstools, the structure of the organs bearing the spores and the dispersal of the spores themselves take a very large share; indeed, the only part of the fungus plant known to most people, namely, the mushroom or toadstool, has solely to do with the formation and dispersal of the spores. In a previous article on this subject (see "KNOWLEDGE," Volume XXXVII, pages 98, 124, 168) the question of spore-formation and dispersal has already been gone into, and it will not be further mentioned in the present paper.

In the common mushroom the plant itself is formed of fine threads, called mycelium (see Figures 100 and 102), which live in the soil and obtain their nourishment from the organic matter contained therein. The mushroom plant is entirely free from chlorophyll, and is therefore incapable of obtaining any of its organic constituents from the air. It feeds exclusively on formed organic matter. When the mushroom plant has obtained a sufficient store of nourishment spore-production begins, and what we call mushrooms then appear. These organs are wonderfully adapted for the production of myriads of tiny spores, which are carried broadcast by the wind, and when they fall on suitable material they rapidly germinate and produce fresh mycelium. Fungus plants have again and again been grown on various sterilised materials from their spores, and have been induced to go through their complete life-cycles. Fischer was able to grow the Beechtuft (*Armillaria mucida*) (see Figures 118 and 122) from its spores on sterilised bread kept moist, and to obtain from it typical toadstools, which ripened a second crop of spores in fifty-eight days from the time the first spores germinated. When the spore germinates it puts out a thread-like process, which gradually elongates, and, later on, begins to branch. The process tends to grow in the direction of any nutritive substance on which the fungus feeds. The attraction is simply chemiotaxis, and does not imply any vital function. The Japanese, Miyoshi, sowed fungus spores on a plate of mica, which was pierced by numerous tiny holes, and rested on a mass of jelly containing sugar and other nutritive substances. He found that the fine threads growing

from the spores travelled along the surface of the mica until they came to one of the tiny holes, down which they passed into the nutritive substance below it. The spores of most fungi germinate best directly they are shed, as they are in most cases frail bodies, easily destroyed by adverse conditions. Fischer showed that the spores of the Beechtuft germinated slowly and with difficulty after a month, and after six weeks failed to germinate at all. Unlike most plants, the fungus plant, or mycelium, is capable of withstanding adverse conditions much better than are its spores. *The mycelium is really the resting stage.*

Toadstools often come up in nearly the same spot year after year. In a garden near the centre of London the Horse Mushroom (*Psalliota arvensis*) (see Figure 103) has appeared every year for the last fourteen years to my certain knowledge. There is an oak tree in Epping Forest on which the Beefsteak Fungus (*Fistulina hepatica*) has been seen by me almost every year for the last ten years. Fries mentions that he had found a somewhat rare toadstool growing from a beech tree in 1815, and that he again found the same fungus appearing from the same crack in the same tree in 1833, but had seen nothing of it in the intervening years. The vulnerability of the spores is so great that some fungi have given up the production of spores completely, and are reproduced entirely by the separation of pieces of their mycelium. A good example of this in the case of ryegrass will be described later. Smut is a disease which affects many of the cereal plants. Its minute spores are sown with the seeds, and directly the seeds germinate the fungus infects the tiny plants. By washing the oats with a disinfectant before they are sown the fungus is killed and smut is prevented. But in the case of barley the treatment is found to be of no value, because the smut fungus enters the ovary of the barley while it is in the flower stage, and thus passes into the seed. In this condition it remains dormant until the seed is sown, when it again awakens into activity. It is probable that the mycelium of most fungi can go on existing for many years in the soil without producing fruit bodies or toadstools. Thus we find that some years mushrooms are very plentiful and in others very scarce. After a warm, wet summer, fields and meadows abound with toadstools which are hardly to be seen at all under more normal circumstances. It is probable in these cases that the mycelium has existed for many years in the soil, but that only after the warm, moist weather has it obtained sufficient vitality to determine on the production of spores by means of toadstools. There is also a certain amount of evidence to show that some kinds of toadstools are found in abundance in some localities every third year. It is clear, then, that the mycelium, and not the spore, is the true resting stage in the case of many fungi.

In some forms of fungus the mycelium forms itself into a firm, dense mass before passing into the resting stage: these masses are called "sclerotia." Hard black bodies are not infrequently seen in the interior of the dead stems of the potato, cucumber, and many other plants. These remain dormant for a time, and later on the fructification of the fungus, shaped like a cup in many cases and connected to the sclerotium by fine threads, appears. The pretty little toadstool shown in Figure 99 is usually found growing on the dead "fruit" of another of its kind. From the mycelium small sclerotia are produced, and from these the tiny toadstools spring up. Ergot is another example of a sclerotium. Large elongated bodies are seen, which form the resting stage of the fungus. They fall to the ground in autumn, and remain there dormant all the winter. From these black bodies short stalks with purple heads arise in spring, and from these the spores are given off. In some fungi the resting mycelium takes the form, not of sclerotia, but of strands and threads: these are spoken of as "rhizomorphs." Dark, hair-like threads are often found among dead leaves: they are rhizomorphs of a species of *Marasmius*. Underneath the bark of many a dying tree dark interlacing cords may be observed which are the rhizomorphs of the Stumptuft (*Armillaria mellea*) (see Figures 101 and 104), one of the most destructive of parasitic fungi, and the cause of one of the most serious forms of timber disease. The fruits of the Stumptuft are generally found near the bases of trees. A large mass of them appears in Figure 101. The fungus reaches the trees in many cases through a wound, and the mycelium from the germinating spore spreads in the cambium, that is, the growing tissue between the bark and the wood, and forms its rhizomorphs in this region. As it extends inward the wood is destroyed and the tree is slowly killed, and from the root of the infected tree rhizomorphs extend through the soil to infect other trees. From these rhizomorphs the fruit or toadstool may be formed, so that Stumptufts may be found some little distance from the tree on which their mycelium is growing (see Figure 101). It is an interesting fact that rhizomorphs which carry infection from tree to tree are hardly ever found more than six or eight inches from the surface of the soil. A trench at least a foot deep round an infected tree will prevent the spread of the disease by the means of rhizomorphs to other trees around.

That many toadstools tend to come up in rings has been noticed for a very long time, and many fantastic suggestions have been invented to explain the fact, several examples of which may be seen in Figures 105, 106, 108, and 110. The best known of these is perhaps the Fairy-ring Toadstool (*Marasmius oreades*), but gigantic rings of the Giant Puffball (*Lycoperdon giganteum*) are also often seen on limestone downs, and it is curious that in most cases when no toadstools are to be found the rings are still recognisable through the darker colour

FIGURE 99. *Collybia tuberosa* growing on a dead toadstool.

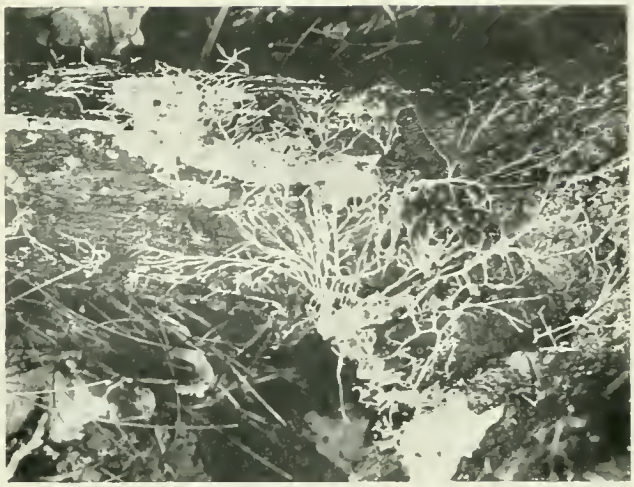


FIGURE 102. The mycelium of a fungus which has spread to the under surface of a decaying log of wood, from the dead leaves on which it was lying.

FIGURE 100. *Flammula sapinea* growing on dead leaves. The fine white threads of the mycelium or true fungus plant are seen in the soil, and also attached to the stalk of one of the toadstools which has been pulled up.

FIGURE 103. The Horse Mushroom (*Psalliota arvensis*). Specimens found growing in a garden in the middle of London.

FIGURE 101. The Stumptuft (*Armillaria mellea*).

FIGURE 104. Young, imperfectly expanded specimens of the Stumptuft (*Armillaria mellea*).

FIGURE 105. The Champignon, or Fairy-ring Toadstool (*Marasmius oreades*).

FIGURE 108. Fairy ring of *Collybia maculata* growing on dead leaves in a wood.

FIGURE 106. Toadstools from a fairy ring of *Marasmius oreades*.

FIGURE 109. A fairy ring of St. George's Mushroom (*Tricholoma gambosum*) with a ring of thistles growing just inside it.

FIGURE 107. *Lactarius rufus*, a toadstool containing a milky juice which exudes when the fungus is injured.

FIGURE 110. Part of a very large ring of St. George's Mushroom (*Tricholoma gambosum*).

and richer growth of the grass in their neighbourhood. The explanation of the phenomenon is very simple. The fungus plant gets a foothold in the soil in many cases, it is thought, owing to the local manuring of the ground by the droppings of some animal. In due course in the autumn, or in the case of the St. George's Mushroom (*Tricholoma gambosum*) (see Figure 110) in the spring, a crop of toadstools is produced, and the nourishment of the soil in this area being largely exhausted, the mycelium spreads out in all directions in search of fresh supplies. The result is that next autumn a small ring of toadstools is produced, and, provided that the character of the soil is uniform, every year a larger ring will be found. It is probable that the richer growth and darker colour of the grass are due to the manuring of the soil by the decayed toadstools of the previous autumn. A friend has told me that he has noticed that a ring of Champignons, or Fairy-ring Toadstools (*Marasmius oreades*) (see Figure 105) which is growing on his lawn gets a little larger every year. When the rings become very large they sometimes cease to extend, and are even said occasionally to get smaller again. Any change in the character of the soil will, of course, tend to break up a ring by producing unequal growth in different regions, and for this reason fairy-rings are but rarely seen excepting where the soil is very uniform; where the soil changes, or where two rings intersect, they often become broken up. Figure 109 is interesting: it shows a ring of thistles growing just inside a ring of the St. George's Mushroom. I have seen many such rings on the downs, near Lulworth. It may be that there is some symbiotic relationship between the thistle and the fungus by which the growth of the one helps that of the other, or it may be simply that the seeds of each year's crop of thistles are able to germinate more freely in the soil broken up and manured by the toadstools.

Most wonderful stories are told of the lifting power of growing mushrooms and toadstools. There is an asphalt path in a London garden some part of which is raised every year by a crop of Horse Mushrooms (*Psalliota arvensis*) (see Figure 103). It is indeed curious that such evanescent and fragile structures as mushrooms and toadstools should be capable of exerting such force. The growth of a mushroom depends on the rapid transference of material from the mushroom plant or mycelium to its growing "fruit." The rapidly growing cells of this attract to themselves large quantities of food matter and fluid which exude into them by osmosis, and by the pressure thus exerted the work is done.

In cellular structure the fungi differ essentially from most ordinary plants: instead of being formed by polygonal cells pressed together in the form of a mosaic, the tissues of the fungi are composed of elongated tubes, divided in some cases by septa, which ramify in different directions, and are more or less easily separated from one another. The spaces between these tubes are filled in with a certain amount of connecting material and by air. Sometimes cross-connections are seen between parallel tubes, so that a figure resembling a capital "H" is formed. When divisions occur in the tubes dividing them into cells, little projections are sometimes seen which connect the two adjoining cells: these are spoken of as clamp-connections. Some fungi also possess much larger branched cells, which contain a milky fluid. The fluid is in some cases clear, but usually white and milk-like, and is sometimes coloured. In *Lactarius deliciosus* the milk is orange-red. The genera *Lactarius*, *Mycena*, and *Fistulina* all possess this latex, or milky fluid. In some species of *Lactarius* (see Figure 107) it is acrid and unpleasant to the taste, and contains a resinous substance. The fluid is probably protective in function, and exudes freely when the fungus is injured. The fact that the cells containing it are most abundant on the surface of the stalk and in the neighbourhood of the gills, regions where any injury would be especially harmful, makes this supposition the more probable.

Fungi have occasionally been observed to give forth a phosphorescent light of a pale yellow or greenish colour. It has been observed especially in connection with Australian species; and although in some cases it may be due to bacterial action from commencing putrefaction, in most cases it is the fungus itself which gives forth the light. The light is usually most intense where rapid growth is taking place, as, for instance, at the edge of the cap, and has been noticed in the toadstools and mycelia of white spored varieties more than in any other forms. But it has also been seen in rhizomorphs, and especially in *Corticium coeruleum*, which forms blue films on decaying wood.

Fungi are very widely distributed in nature, and turn up sometimes in most unexpected places. Even at the rocky summit of the highest mountains they are to be found as one of the partners of the joint-stock firms of plants which we call "lichens." M. C. Cooke tells us that about sixty-four per cent. of the larger fungi are terrestrial, about seven per cent. grow on dead leaves, and about twenty-nine per cent. are found on wood; and, of course, each special locality has its individual fungus flora. Because a fungus is found growing on the ground it is by no means certain that it is obtaining its nourishment from the ground, for it may be attached by visible or invisible threads of mycelium to a dead stump or the root of a tree on which the fungus plant is growing. A few of the habitats of various types of fungus are seen in the accompanying photographs (see Figures 111 to 113). Some varieties are very exclusive. *Claudopus variabilis* (see Figure 114) is generally found growing on dead grass. *Collybia conigena* (see Figure 115) grows almost exclusively on the cones of firs, and not a few parasitic fungi are confined to

one species of plant. Indeed, in some of the smaller parasites, specialisation has gone so far that a given fungus will only grow on a single variety of host plant.

The ecology of fungi, or their relationship to the environment in which they grow, is a subject about which little is known. Toadstools seem less influenced by the mineral character of the soil than by the other plants which are growing with them. The Morel (*Morchella esculenta*) (see Figure 116) is, however, to some extent confined to limestone districts. Every variety of wood has its definite fungus flora, which is fairly constant from year to year. The toadstools met with in a pinewood are very different from those found in an ordinary mixed wood, but in both we find the same species coming up at approximately the same spot year after year. Should, however, any change in the character of the wood take place, such as the cutting down of a number of the trees or extensive removal of the undergrowth, a great change in the fungus flora is at once to be noticed. Generally it may be said that the presence of thick brushwood seems to interfere with the development and growth of fungi. The constant association of certain toadstools and certain trees, as, for instance, the Fly Agaric (*Amanita muscaria*) (see Figure 119), which is almost exclusively found near birch trees, suggests that there may be some symbiotic relationship between the two plants by which one is of some assistance to the other. Massee is of opinion that the mycelium of black-spored toadstools is destroyed by that of toadstools with lighter-coloured spores, or that, at any rate, its growth is much interfered with. But I have seen a variety of Coprinus with black spores growing apparently happily on the same log with white-spored species. Sometimes four or five different varieties of toadstool are seen on the same decaying tree, and one would very much like to know how the mycelium of each is behaving with regard to that of the others. Two species of *Polyporus* (*P. ignatarius* and *P. dryadeus*) both grow on the oak parasitically. When growing alone, each absorbs the starch contained in the medullary rays, as well as the lignin of the wood; but when the oak is infected by both together, the starch of the medullary rays remains intact, although the lignin is absorbed. Why this is nobody knows.

Fungi are not infrequently to be found in most unexpected places, and some seem almost invariably associated with human habitations. When a waterpipe bursts inside a house, or the rain comes in through the roof, a wet place is seen on the wall or ceiling. If the leak is not attended to, and the area remains damp for several days, a pink or pale brown discoloration soon becomes visible, especially if the affected area is whitewashed or plastered. If the discoloration is examined carefully, and especially if a pocket lens is used, it will be noticed that the colour is due to a number of minute raised spots, all of about the same size. These spots are the fructifications of a tiny fungus (*Peziza domestica*) which appears to grow exclusively on a moist whitewashed surface. Another fungus, which we sometimes meet with to our cost, is the Dry-rot Fungus (*Merulius lacrymans*) (see Figure 117). The "lacrymans" part of the name refers, not to the tears of the householder—appropriate as they may be—but rather to the large clear drops of moisture which are exuded from the fruit of the fungus. Often the first indication that we have of the presence of the dry-rot fungus is the repeated appearance of a fine brown dust which comes into the room through a crack in the floor or wainscot, and is in reality some of the spores given off from the fructification. A little later on the woodwork may appear moist, or, if covered by paint, a certain amount of warping may be noticed, or even at times the first thing that may be observed is that the floor gives way, and somebody's foot nearly goes through. The fungus grows best in dark, moist, unventilated places; but even where such areas are dry the plant, spreading from moist soil or brickwork, may carry sufficient moisture with it to destroy the timber or woodwork which it invades. Wood that is infected by the fungus is either moist, soft, and reddish brown in colour, or else dry, brown, and powdery, and much lighter in weight than ordinary wood; and in any case, whether wet or dry, it is much more brittle than healthy timber. The mycelium of the fungus is white and silky: it may sometimes be seen spreading over the surface of boxes or woodwork in dark cellars. Apart from the dwellings of man the fungus is rarely seen, but I have once met with its fruit growing on a forest tree. For a long time all attempts to induce the spores of the dry-rot fungus to germinate experimentally proved unsuccessful, but when the nutritive medium was made faintly alkaline by the addition of ammonia, the spores grew readily; and it is probable that ammonia is very often present in minute quantities in the atmosphere of the dark, unventilated spots where the fungus has its home.

A group of fungi which I found growing from a roof of a London cellar is seen in Figure 121. These were hanging downwards, and the attempt made by the plant to get its gills into the vertical plane, so that its spores may be satisfactorily shed, is clearly seen in the photograph. *Clitocybe tabescens* is not exclusively found in connection with mankind. It grows also in the forest on decaying wood.

There would seem to be no very hard-and-fast line of division between fungi which live exclusively on dead material and those which are capable of attacking living animals and plants. Not a few seem to be able to grow equally successfully as saprophytes and parasites. A good many parasitic fungi are in nature confined to a single species of plant, but it has been found possible in some cases

FIGURE 111. *Psilocybe canobrunnea*, a toadstool that is found in open fields.

FIGURE 114. *Claudopus variabilis*, a small fungus usually found growing on dead grass.

FIGURE 112. "Blewits" (*Tricholoma nudum*), a toadstool which grows on dead leaves.

FIGURE 115. *Collybia conigena*, found exclusively on pine cones and pine needles.

FIGURE 113. The Sulphur-tuft (*Hypholoma fasciculare*), toadstool that grows on dead wood and buried stumps.

FIGURE 116. The morel (*Morchella esculenta*), much more abundant, as a rule, on limestone than on other soil.

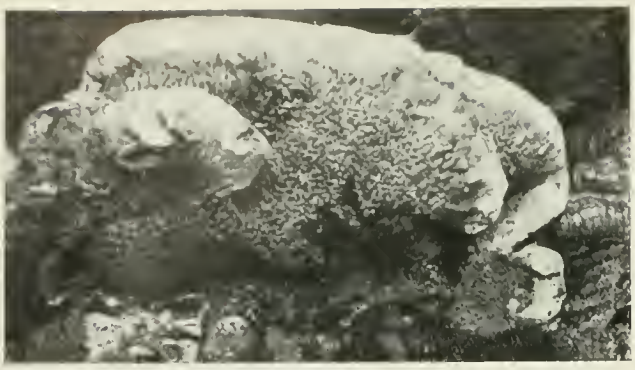


FIGURE 117. Fructification of a Dry-rot Fungus (*Merulius lacrymans*).

FIGURE 120. *Fomes annosus*, a parasitic fungus which causes a good deal of disease in timber-producing trees.

FIGURE 118. The Beechtuft (*Armillaria mucida*) growing on a beech trunk.

FIGURE 121. *Clitocybe tabescens*. Specimens found growing in a dark cellar.

FIGURE 119. The Fly Agaric (*Amanita muscaria*) is almost exclusively found near birch trees.

FIGURE 122. The Beechtuft (*Armillaria mucida*).

to produce experimentally a variety or strain of some of them which is capable of attacking a second plant, by injecting the juices of the first into the tissues of the second. After several generations of this treatment the fungus has been rendered capable of attacking the second host directly. Massee has also experimentally induced a saprophytic fungus to become parasitic. *Trichothecium candidum* is only found in nature growing on dead substances. But by injecting sugar into the leaves of a Begonia this fungus has been induced to attack the plant, grow on it, and produce normal spores. Spores of the second generation were sown on another Begonia plant in exactly the same manner, except that less sugar was injected into its leaves, and the experiment was continued until, after twelve generations, a strain of *Trichothecium* was produced capable of infecting a Begonia leaf directly without the previous injection of any sugar at all. It has also been shown that plants normally immune to infection by certain fungi may become susceptible if they are first injured. It is probable that a good many fungi which are found growing on living trees usually obtain a footing in the tissues of the tree by attacking a branch injured by wind or storm. The beech-tuft (*Armillaria mucida*) (see Figures 118 and 122) —a beautiful ivory-white toadstool found growing on living beech trees, often in great abundance— is an instance of this. All appearances indicate that it is definitely parasitic in nature ; but, though Fischer was able to cultivate it from its spores, and get it to produce fructifications while growing on sterilised bread and beech wood, all attempts which he made to infect living beech trees failed entirely. Probably in nature the fungus only grows on beech trees which have been prepared for it by the growth of some other fungus, or it may be that it starts growth as a saprophyte on some dead branch, and then obtains sufficient vigour to attack the living parts of the tree.

There appears to be no doubt at all that *Fomes annosus* (see Figure 120) is a true parasite on living trees. The mycelium is found between the wood and the bark of the roots and lower part of the stem in fir trees as a layer of fine, silky threads, which can be seen through a crack in the bark bulging outward. The mycelium secretes a ferment which dissolves out the lignin from the wood of the lower part of the trunk of the tree, and in time makes it hollow ; indeed, foresters are able to recognise the presence of the parasite before any great change takes place in the general nutrition of the tree by the hollow sound produced when the tree is struck. The fructifications of the fungus, which take the form of somewhat irregularly shaped projections composed of masses of fine, vertical tubes open below, are generally borne on the exposed roots of the infected trees, and are often seen where the roots have been laid bare by the burrows of foxes and rabbits.

(To be continued.)

SCIENCE IN THE DAILY PRESS.

RECENTLY Professor R. A. Gregory, the Assistant Editor of *Nature*, read a paper before the Circle of Scientific, Technical, and Commercial Journalists, in which he considered the accuracy of statements which appear in the newspapers and weekly periodicals, and discussed literary and scientific writers, as well as some public beliefs which have been shown to be erroneous. He said : " It is scarcely too much to say that, omitting signed articles written by experts, few newspapers make any announcement relating to a scientific subject without committing a mistake. Either terms are wrongly used, or a matter of common knowledge among men of science is regarded as a remarkable discovery, or observations of a sensational kind are presented to the public as if they were established truths, though they await confirmation from the scientific world, and are mostly unworthy of serious consideration.

" It seems to be too much to expect literary people to possess an elementary knowledge of science, or to have any sympathy with scientific precision, but it is not unreasonable to ask for accuracy of description when they are dealing with natural facts and phenomena.

" We are often told that men of science should cultivate the art of literary expression, but the stronger necessity for literary men to have at least a nodding acquaintance with the outstanding facts of natural knowledge is overlooked. The first business of the man of science is to create new knowledge, and not necessarily to clothe his discoveries in a pleasing dress, though he may do so."

Two examples were given by Professor Gregory where scientific enquiry had failed to support popular opinion. One was alleged change of climate, and the other the connection between the Moon and the weather. When meteorological records are examined they show that the temperature, rain, frost, and so on, are much the same at the present time as they were in the early days of the declining generation. Moreover, " from an examination of old records, and of the long series of observations made at Greenwich, Sir John Moore was able to show to the British Association, in 1908, that no appreciable change has taken place in the climate of the British Isles during the past six centuries.

" The only definite association that can be regarded as established between changes of the Moon and weather is that thunderstorms are slightly more frequent near New Moon and the First Quarter than near Full Moon and the Last Quarter ; and it is noteworthy that this is overlooked completely in proverbial philosophy."

Other fallacies touched upon were that the noise of guns causes rain, that there is flame from a volcano, and living toads and frogs are found in blocks of coal and other rock, or that there is such a thing as a thunderbolt.

With regard to the last part of his subject, Professor Gregory said that " the public likes to believe that men of science predicted from theory that this or that thing was impossible which was afterwards achieved ; and its literary guides usually associate a great discovery, not with the man whose work in the laboratory or study led to it, but to the man who made a commercial success of it. It was the mathematical work of Clerk Maxwell and the scientific experiments of Hertz which produced wireless telegraphy, but to the popular press the only man responsible for this wonderful discovery is Mr. Marconi."

CHAPTERS IN SPECTRUM ANALYSIS.

By W. MARSHALL WATTS, D.Sc.

I.—Law and Order in Spectra.

A. Line Spectra.

(*Continued from page* 101.)

In the spectrum of lithium, besides the principal series, three other series have been observed. Two of these—the "diffuse" (or first subordinate) and the "sharp" (or second subordinate) series have the same convergence-frequency at 28579·35.

The formula for the diffuse series is :—

$$\text{O.F.} = 28579{\cdot}35 - \frac{109675}{\left(m + 1{\cdot}00117 - \frac{{\cdot}00588}{m}\right)^2}$$

and that for the sharp series is :

$$\text{O.F.} = 28579{\cdot}35 - \frac{109675}{\left(m + {\cdot}602191 - \frac{{\cdot}013039}{m}\right)^2}$$

The Diffuse Series in Lithium.

m.	Observed.	Calculated.	O—C.
2	6103·83	6103·81	+ ·02
3	4602·37	4602·38	− ·01
4	4132·44	4132·49	− ·05
5	3915·39	3915·45	− ·06
6	3795·18	3795·13	+ ·05
7	3719·0	3721·17	−2·17
8	3670·6	3672·01	−1·41

The Sharp Series in Lithium.

m.	Observed.	Calculated.	O—C.
2	8127·17	8127·17	0
3	4972·11	4972·12	− ·01
4	4273·44	4273·46	− ·02
5	3985·86	3985·89	− ·03
6	3838·3	3836·01	+2·3

Certain remarkable relationships between the different series have been observed, which show that they are not independent of each other. If, for brevity, we denote the three series by P, D, and S, and their convergence-frequencies by P_∞, D_∞, and S_∞, the first relationship is that $D_\infty = S_\infty$.

In the next place $P_\infty - S_\infty$ gives the oscillation-frequency (P_2) of the principal series. Thus in lithium

$P_\infty = 43482{\cdot}52$

$S_\infty = 28579{\cdot}35$

$P_2 = 14903{\cdot}17$

which corresponds to the wave-length 6708·16. The following are the observed values of this line :—

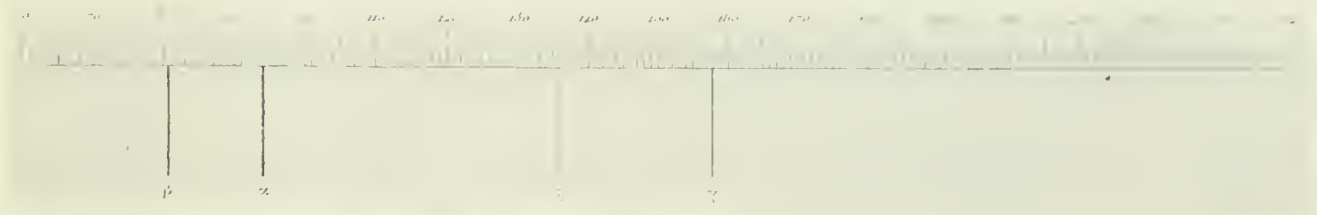
6708·0 Ramage, in flame.
6708·2 Kayser and Runge, in arc.
6708·10 Exner and Haschek, in arc.
6708·2 Eder and Valenta, in spark.
6708·09 Exner and Haschek, in spark.

This relationship was discovered independently by Rydberg and by Schuster, and is generally called the "Rydberg-Schuster Law." This law probably holds good for all elements. It is interesting to note that in 1896 Schuster predicted that a pair of caesium lines, at about 8908 and 8518, would be found in the infra-red—a prediction verified by the discovery of the pair $\left\{\begin{matrix}8949{\cdot}92\\8527{\cdot}72\end{matrix}\right\}$ by Lehmann in 1901. A "diffuse" series and a "sharp" series exist in the spectra of sodium, potassium, rubidium, and caesium, each series consisting of *pairs* of lines, as in the corresponding principal series. These subordinate series have the pairs of lines always at the same distance apart, as measured in oscillation-frequency, whereas in the principal series they get closer and closer together as they approach the convergence-frequency. Further, the constant difference in the two subordinate series is exactly that of the first pair in the principal series. This difference is 17·19 for sodium, 57·87 for potassium, 237·98 for rubidium, and 553·96 for caesium, these numbers being approximately as the squares of the atomic weights of the corresponding elements.

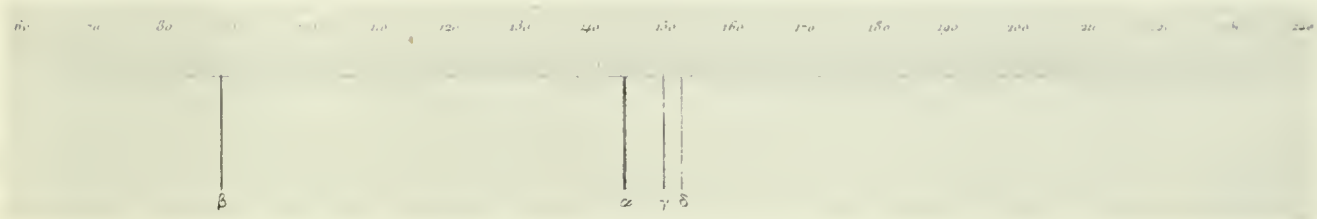
In sodium the common convergence-frequency of the diffuse and sharp series is 24475·89 for the less refrangible lines, and 24475·89+17·19=24493·08 for the more refrangible lines. If we subtract these numbers from 41448·67, the convergence-frequency of the principal series, we get 16972·78 and 16955·59 as the oscillation-frequencies of the two P_2 lines, and these correspond to the wave-lengths 5890·19 and 5896·16 respectively. The observed values of these lines are :

$\left\{\begin{matrix}5890{\cdot}19\\5896{\cdot}16\end{matrix}\right\}$ Kayser and Runge, in the arc.
$\left\{\begin{matrix}5890{\cdot}182\\5896{\cdot}154\end{matrix}\right\}$ Rowland, in the sun.
$\left\{\begin{matrix}5890{\cdot}18\\5896{\cdot}15\end{matrix}\right\}$ Eder and Valenta, in the arc.
$\left\{\begin{matrix}5890{\cdot}20\\5896{\cdot}17\end{matrix}\right\}$ Exner and Haschek, in the arc.
$\left\{\begin{matrix}5890{\cdot}21\\5896{\cdot}18\end{matrix}\right\}$ Exner and Haschek, in the spark.

Sodium and Lithium. Flame Spectrum.

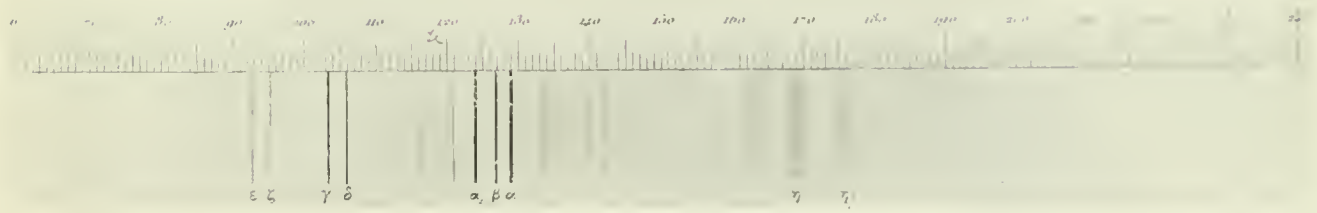


Lithium Spark. Spectrum.

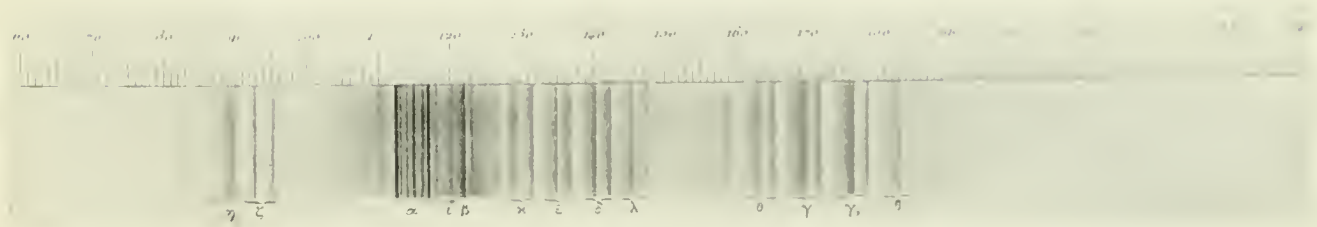


Zinc Spark. Spectrum.

Cadmium Spark. Spectrum.



Copper Chloride. Spark Spectrum.



Copper Chloride. Flame Spectrum.

FIGURE 123.

(After Lecoq de Boisbaudran.)

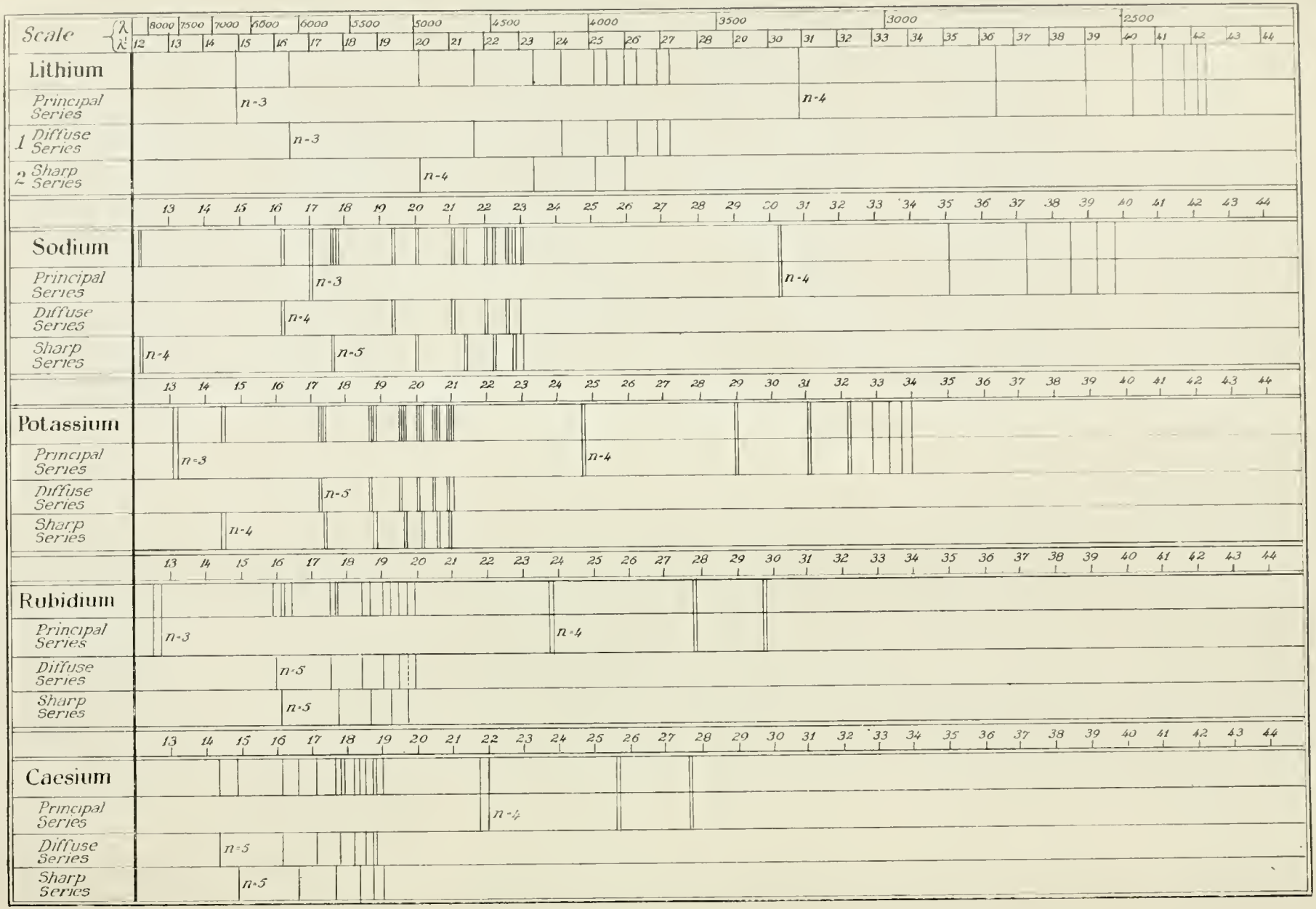

Scale
λ 8000 7500 7000 6600 6000 5500 5000 4500 4000 3500 3000 2500
λ² 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44
Lithium
Principal Series
n-3
n-4
1 Diffuse Series
n-3
2 Sharp Series
n-4
Sodium
Principal Series
n-3
n-4
Diffuse Series
n-4
Sharp Series
n-4
n-5
Potassium
Principal Series
n-3
n-4
Diffuse Series
n-5
Sharp Series
n-4
Rubidium
Principal Series
n-3
n-4
Diffuse Series
n-5
Sharp Series
n-5
Caesium
Principal Series
n-4
Diffuse Series
n-5
Sharp Series
n-5

FIGURE 124.

In potassium the common convergence-frequency of the two subordinate series is 21967·5 for the less refrangible lines, and 22025·37 for the more refrangible lines of the pairs. Subtracting these numbers from 35005·56, the convergence-frequency of the principal series, we get 13038·06, and 12980·19 for the two P_2 red lines; and these numbers correspond to the wave-lengths 7667·77 and 7701·96 respectively. The observed values of these lines are:

7668·54, 7701·92 } Lehmann, in the arc.
7665·6, 7699·3 } Kayser and Runge, in the arc.
7666, 7699 } Eder and Valenta, in the flame.

For rubidium the mean convergence-frequencies of the subordinate series are 20872·7 and 21110·68 and $P_\infty = 33688·20$. These numbers give $P_2 = \{7800·94, 7948·6\}$, the observed values being:

7800·3, 7947·7 } Eder and Valenta, in the arc.
7800·2, 7947·6 } Saunders, in the arc.

For caesium the corresponding numbers are 19672·9 and 20226·86 and $P_\infty = 31404·6$. These numbers give $P_2 = \{8521·73, 8943·96\}$, the observed values being 8527·50, 8949·67 } Lehmann, in the arc.

Here the correspondence is not quite so good: a result to be expected perhaps from the difficulty of determining accurately the wave-lengths of lines lying far in the infra-red.

The observation that the pairs of lines in the subordinate series have the same difference in oscillation-frequency is important. In the case of sodium the interval 17·2 occurs twenty-three times; in potassium the interval 57·9 occurs thirteen times, and the interval 238· occurs sixteen times in rubidium. These are instances of what is known as the "law of constant differences," discovered by Hartley, who observed (in 1883) that three triplets in the spectrum of zinc corresponded with three triplets in the spectrum of cadmium, and that in each of these spectra the triplets have their lines equally spaced if mapped on the scales of oscillation-frequency. The photographic reproduction of Lecoq de Boisbaudran's drawings of the spectra of zinc and cadmium shows these triplets plainly (see Figure 123). Such triplets characterise the spectra of magnesium, calcium, strontium, zinc, cadmium, and mercury, the "scale" on which the triplets are spaced being proportional, more or less nearly, to the squares of the atomic weights.

In the reproduction of Lecoq de Boisbaudran's spectra of zinc and cadmium the first triplets of the sharp series are marked α, γ, δ and α, β, δ respectively. The wave-lengths and oscillation-frequencies (*in vacuo*) of these lines are:

IN ZINC.

Wave-length.		Oscillation-frequency.	
4810·75	...	20781·08	Difference 579·00
4722·36	...	21170·06	
4680·35	...	21360·08	

IN CADMIUM.

5086·08	...	19656·52	Difference 1712·60
4800·11	...	20827·17	
4678·37	...	21369·12	

If these differences are proportional to the squares of the atomic weights, we can calculate that of zinc from that of cadmium, namely, 112·40; making the calculation we obtain for zinc the number 65·358, whereas the atomic weight of zinc determined by chemical methods is given in the International Table for 1915 as 65·37.

The diagram which accompanies this article (see Figure 124) is a reproduction of the diagram given by Kayser and Runge in their paper of 1890, and shows the spectra of the alkalies as known at that time. The spectra are mapped upon the scale of oscillation-frequencies, and the scale of wave-lengths is also shown under each element. The complete spectrum is shown in the top line, the next line shows the principal series, the third line shows the diffuse series, and the fourth line the sharp series. The scale of the drawing is too small to allow of the pairs of lines being properly represented: they are shown too far apart.

(To be continued.)

KHAKI DYE.

THE present shortage in this country of synthetic yellow dyes has put considerable difficulties in the way of manufacturers of khaki cloth. A temporary way out of the trouble was found, however, by the increased use of fustic, a natural yellow dyestuff, consisting of the wood of a tree (*Chlorophora tinctoria*) which grows freely in Jamaica and also in British Honduras. At the outbreak of the war there was only a small supply available in Europe, though fortunately one of the prizes captured from Germany had a considerable consignment on board. A certain amount, too, has been obtained from France, which country and the United States have hitherto taken the bulk of the fustic exported from Jamaica. When the shortage of yellow dyestuffs in this country first became apparent the Imperial Institute took steps to place British dye firms in touch with exporters of fustic in Jamaica. Only a moderate amount of cut fustic wood was, as it happened, then available in the island, but as a result of the Institute's action the Government of Jamaica has offered to purchase from the growers further supplies, and carry these, at Government cost, to Kingston, the port of shipment. The Government of British Honduras is also taking action in this matter, and a further supply of the wood may possibly be forthcoming from that colony.

GERMAN SCIENCE.

By Prof. J. ARTHUR THOMSON, M.A., LL.D.

A comparative survey of the scientific productivity of different nationalities, such as we have attempted in some detail in a contribution to the symposium entitled "German Culture" (Jacks, 1915), is obviously beset with great difficulties. One of these is involved in the fact that a nationality is made up of various racial strains, differing widely in their scientific and other qualities. To take a familiar illustration, how is the historian of biological science to be sure how many of the famous physiologists and pathologists of Germany must be ranked racially as Jews? There have also been potent immigrations, well represented by such men as the physiologist Haller, the botanist Nägeli, the zoölogist Kölliker, the mathematician Euler, who were identified with Germany in their life and labours, but belonged by birth to Switzerland. Another difficulty in comparison is that, after we have taken account of the few giants whom all the world acknowledges, we encounter extraordinary differences of opinion as to the merits of even famous investigators. Thus in the history of science some will attach considerable importance—rightly, we think—to Goethe, and others none at all. Some will compare Haeckel with Huxley, while others regard him as quite second class. Some will compare Ehrlich and Almroth Wright, Koch and Pasteur, while others regard the collocations as far from felicitous. Some will compare Helmholtz and Kelvin, Kirchhoff and J. J. Thomson, Hertz and Fitzgerald, while others regard this as betraying a loss of perspective. The reasons for this divergence of opinion are several. "Every man for his own country" is one; another is that there are several distinct species of scientific discoverer; and a third is that while one valuator is thinking of the investigator's mental ability, another is considering the influence that his teaching or his published work has had on the development of science. There is a further difficulty in a comparative valuation, conducted in public, that not a few of the very greatest names are quite unfamiliar even to the omniscient general reader. Thus, to take a diagrammatic illustration from the essay already mentioned, we believe it to be true that the names of Green (1793–1841), Galois (1811–1830), and Gauss (1777–1855) stand for mathematical achievements of the very highest order, but how few outside of the ranks of mathematicians know anything about these three geniuses, or any one of them! We doubt if Green has even the honour of an article in the "Encyclopaedia Britannica"! Marconi is much better known than Galvani, and Edison than Willard Gibbs; and it is quite natural that it should be so. The work of those who lay foundations is rarely known to spectators; it is not rightly appreciated save by the greater builders.

One of the impressions that we get from a geographical survey of scientific productivity is that of the widespread distribution of discoverers. Wherever two or three are gathered together in the name of Pallas, there the revealing spirit is at work. Nor is the solitary devotee left unrewarded. To think of Italy is to remember Galileo and Galvani, Volta and Veronese, Avogadro and Borelli, Cannizzaro and Spallanzani, to take the names as they tumble out. Russia recalls von Baer, one of the few very great minds who have given their life to Biology; Kowalevsky, who discovered the affinities of Ascidians; Metschnikoff, with his far-reaching theory of phagocytes and inflammation; Mendeléeff, with his Periodic Law; the mathematical genius Lobachevski; the physiologist Pavloff, and many other investigators of extraordinary brilliance. We cannot pass to Poland without thinking of the scientific chain linking Madame Curie (Marie Sklodowska) to Copernicus, or of the wonderful family of the Bolyai. Austria makes one think of Mendel, whose work has changed all our thinking in regard to heredity, and of the Viennese school of medicine which began with Rokitansky. Sweden was the home of Linnaeus and of a succession of great chemists from Berzelius to Arrhenius. Speaking of chemists reminds us of the great part Holland has recently played through Van 't Hoff and Van der Waals, and Belgium through Le Bel. The Dutch contributions to physical science have been of high importance from Huygens—more or less contemporary with Newton—to Lorentz of to-day. One other reference must suffice, and that not to Britain, France, or Germany, which have each their galaxy of great investigators, but to the small country of Switzerland, with Haller as physiologist, Louis Agassiz as palaeontologist, Kölliker as zoölogist, Euler and the Bernoullis as mathematicians, Nägeli as botanist, and so on. In fact, every civilised country has its scientific roll of honour, though in some cases it is no longer than it should be.

A second impression that we get from an impartial comparative study is that Britain, France, and Germany run neck and neck. If we take a series of more or less analogous names, without attaching too much importance to this rough-and-ready method, we see that the balance dips now to one side and now to another. If we could, as we cannot, represent the merits of three counterparts—British, French, and German—by the three sides of a triangle, the lengths would now be in favour of Britain, again in favour of France, and again in

favour of Germany; yet a superposition of a number of triangles sufficiently large to get rid of conspicuous inequalities would yield a not very irregular figure. This, at least, is one of the conclusions arrived at in the detailed essay we have cited. Let us take a few examples, the British representatives being alphabetically arranged.

British.	French.	German.
Balfour, F. M.	Lacaze-Duthiers	Roux
Dalton	Lavoisier	Bunsen
Darwin	Lamarck	Kepler
Davy	Legendre	Weber
Faraday	Fourier	Clausius
Fitzgerald	Becquerel	Hertz
Foster	Claude Bernard	Ludwig
Galton	Delage	Weismann
Graham	Berthelot	Liebig
Green	Galois	Gauss
Hunter	Cuvier	Gegenbaur
Harvey	Bichat	Humboldt
Hooker	A. de Jussieu	Sachs
Huxley	Buffon	Haeckel
Joule	Carnot	Mayer
Jenner	Bordet	Behring
Kelvin	Laplace	Helmholtz
Lankester	Giard	Johannes Müller
Lister	Pasteur	Virchow
Lodge	Ampère	Ohm
Maxwell, Clerk	Poincaré	Boltzmann
Ross	Laveran	Koch
Burdon-Sanderson	Brown-Séquard	Bois-Reymond
Spencer	Bergson	Lotze
Smith, Wm.	Gaudry	Suess
Stokes	Lagrange	Cantor
Thomson, J. J.	Cauchy	Kirchhoff
Weldon	Quetelet	Zittel
Wright, Almroth	Richet	Ehrlich

Another impression produced by a detailed survey is that there are distinctive features in the scientific output of the different nationalities. There are a few French-like Englishmen and a larger number who are German-like, and so forth, but on the whole there are definable characteristics. British work seems, not unnaturally, to be marked by its sanity, its true perspective, its self-criticism, and its evidence of having been done for its own sake. French science is distinguished by clearness both of style and vision, by individuality, originality, and defiance of traditions. German investigators are characterised by thoroughness, learning, orderliness, careful technique, and a convinced belief in the value of science as a whole, and of their own contributions in particular. The persistence with which one investigator will give almost the whole of his life to the study of the dogfish head, or another to the nerve cell, or a third to centipedes, with occasional holidays among millepedes, is colossal. There have been changes within recent years, but many German investigators have held firmly to the old tradition of devotedness to the task undertaken, of plain living and high thinking, and of industrious productivity. But besides the tradition there is the temperament, accentuated by habit, of strenuous persistence. They have in high development that quality to which Darwin referred in himself when he said, "It's dogged that does it." No doubt the German investigators, like others, have the defects of their qualities. The demand for output has often led to hasty and purely quantitative work, or the extreme specialism to a loss of perspective, or the standard of thoroughness to tedious prolixity. In other nationalities there is a wholesome prejudice against longwindedness in science, against pushing detailed description beyond the limit of probable utility; but it is characteristic of descriptive science in Germany to recognise no limit but that of the available analytic methods of the day. There is, to be sure, something fine in this, and if it be sometimes a rather ridiculous little mouse that the mountain brings forth, it is usually an irrefutable mouse that has come to stay.

It has been repeatedly asserted during recent months that German science is largely derivative, and that German investigators get hold of the ideas of others, and work them out. This is probably true in regard to certain lines of investigation, just as for others it is true of Britain, Russia, America, and the rest. It is least true of France; but the fact is, that there has been continual cross-fertilisation in the evolution of science. Even if it be admitted that Germany has seen the birth of fewer big scientific ideas than France or Britain—which is doubtful—credit is due to investigators who have detected the promise of dormant seeds, and have brought them to development. To those who remind us that Hertz, for instance, stood on the shoulders of Fitzgerald, it may be answered that Bateson stands on the shoulders of Mendel; and both statements would be ridiculously far off adequate accuracy. If it be maintained that the foundation-stones of the theory of electricity have been mainly laid in Britain, is it not equally legitimate and futile to point to Germany as the cradle and home of cellular biology? And if we are asked how we can for a moment venture to compare German geologists with those of England and Scotland, we wait till the triumphant questioner discovers that, although Suess was born in London, and spent most of his life in Austria, he claimed Saxony as his fatherland. This sort of historical retort might be repeated twenty times over without being far-fetched. When we think of men like Suess, or Helmholtz, or Goethe, or Johannes Müller (to take a few outstanding names), we see the inaccuracy and arrogance of maintaining that the supreme title of genius is inapplicable to German investigators. What appears to be the truth is this, that each of the leading civilised nations has its fair share of scientific discoveries of first-rate importance, but that there is no sufficient evidence for correlating special fertility in scientific discovery with any nationality. Speaking now, not of men of

intellectual eminence, but of the real giants, we believe that the great discoverers represent individual mutations. In its finest expression the discovering spirit means a particular alertness, freshness, eagerness, insight, and cerebral potential—born, not made. The spot of light which marks its emergence shifts from place to place, from nationality to nationality, from race to race, from university to university, shining forth now in Pisa and again in Paris, now in London and again at Leyden, now in Brussels and again at Berlin, now in Edinburgh and again in Petrograd, now in Amsterdam and again in New York. It is a rare spirit, sacred and inestimable, and moveth where it listeth, no one being able to tell whence it cometh, or whither it goeth.

SOLAR DISTURBANCES DURING MARCH, 1915

By FRANK C. DENNETT.

With the exception of the 3rd, the Sun was under observation every day in March, and was never free from spots; whilst on the 2nd as many as seven distinct spot disturbances were visible at one time. The longitude of the central meridian at noon on March 1st was 34° 8′.

Nos. 18, 20, 21, 23, 24, and 25 of the February list continued on the disc until March 2nd, 5th, 6th, 10th, 2nd, and 10th respectively, and therefore reäppear upon the present chart.

No. 26 appeared as pores a little south-west of No. 23 on the 2nd. The leader increased to seven thousand miles in diameter, but the others died out. Last seen on the 9th.

No. 27.—A double group of spotlets and pores, constantly changing their appearance; seen from the 6th until the 11th. Its greatest length was sixty-four thousand miles.

No. 28.—A line of four or five pores, fifty-seven thousand miles in length, in a faculic bed; seen from the 7th until the 13th.

No. 29.—A fine spot, twenty-one thousand miles in diameter; close to the north-eastern limb on the 7th. On the 9th it appeared triangular; next day its umbra was bridged, and two pores followed it. The pores constantly changed position, and on the 14th a bridge of the photospheric matter entirely crossed the spot from north to south. Last seen amid faculae, close to the north-western limb on the 19th.

No. 30.—Broke out on the 14th, close to the central meridian, the northern spotlet being the largest. Next day a line of spots and pores. The length was thirty-two thousand miles, and one of the rear spots became ten thousand miles in diameter. Last seen close to the limb on the 20th.

No. 31.—A group of spots and pores very protean in character, thirty-five thousand miles in length; seen from the 17th until the 22nd. It attained its maximum size on the 20th.

No. 32.—A solitary pore only seen on the 20th.

No. 33.—A curved line of pores in a faculic bed, some thirty-five thousand miles in length; seen from the 21st to the 23rd.

No. 34.—A spot some twelve thousand miles in diameter, first seen on the 23rd. Pores were following it on the 27th, 29th, 30th, and 31st. Last seen on April 2nd. The length was thirty-four thousand miles.

No. 35.—A faculic area had been coming round the south-eastern limb since March 19th, and on the 29th two pores were seen; the leader increased to a spotlet by the 30th, and other spores had developed. The pores not seen after April 1st, or the spot after the 4th. Its greatest length was twenty-nine thousand miles.

No. 36.—Two pores, each situated in a facula, fifty-two thousand miles apart; only seen on the 29th and 30th.

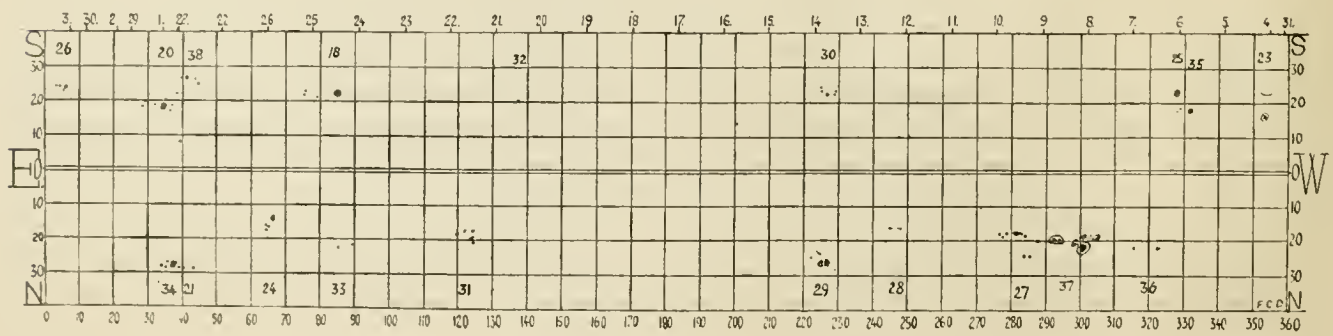
No. 37.—Altogether the finest group seen for several years. First seen as a line within the north-eastern limb on March 29th. Next day it was evident that a considerable group was formed. At first there was a great leader, over forty thousand miles in diameter, followed by a group of spots, which by April 4th had developed into a fine oval spot, thirty thousand by eighteen thousand miles in diameter, containing two umbrae. Behind this were some pores, and a smaller spot bringing up the rear. On April 7th a small spot and pores preceded the great spot, making the total length of the group one hundred and eighty thousand miles. It was closing up to the limb on April 10th, the date of the last record to hand. It extended back into the area of No. 27, and covered that of No. 16.

No. 38.—A group thirty-one thousand miles in length, consisting of five pores, broke out on March 30th, two of which remained visible until the next morning, but were not seen subsequently.

Faculae were recorded within the north-western limb on March 7th to 10th, 14th, 25th to 27th, and 29th to 31st; north-east, 1st, 2nd, 9th, 10th, 16th, 19th to 22nd, 27th, 28th, and 31st; south-west, 6th, 7th, 9th, 11th to 14th, 27th, 30th, and 31st; and south-east, 2nd, 19th to 22nd, and 26th to 31st.

Our chart is constructed from the combined observations of Messrs. John McHarg, W. J. Waters, and F. C. Dennett.

DAY OF MARCH, 1915.



THE CAUSE OF ALBINISM AND DOMINANT WHITENESS.

By H. ONSLOW.

For some time biologists have been aware that white animals may be divided into two distinct classes: albinos, or recessive whites, and dominant whites. These two types are visibly, and were hitherto chemically indistinguishable, being capable of differentiation only by means of the offspring which they produce. The recessive whites, or common albinos, are widely distributed among domesticated animals (*e.g.*, albino mice, rabbits, guinea-pigs, and so on): they have pure white fur and pink eyes, which appear totally devoid of pigment, but which, on microscopical examination, are found to contain minute pigment granules.

Let us suppose an albino rabbit is mated to a self-black rabbit; all their offspring will be the same colour as the coloured parent—that is to say, they will all be black. If these black offspring of the first, or F_1, generation are mated together, they will have black offspring and white offspring in the ratio of three black to one white, in accordance with the simple Mendelian law. The white offspring will, of course, be pure recessives, like their albino grandparent, and will produce nothing but albinos when mated with each other, whereas two thirds of the black offspring will be heterozygous for albinism like their parents, and the other third pure black like their self-black grandparent.

The second type of white animal—dominant white—is superficially indistinguishable from an albino, except that the eyes are usually more heavily pigmented, and occasionally there are flecks of pigment upon the body. Both types of white have a correlated piebald form, in which the white portions of the pattern are respectively recessive and dominant to self-colour. Now, if a dominant white rabbit is crossed with a self-black, all the offspring will be white, instead of black as in the case of the albino; and, if the dominant white is only heterozygous for whiteness, half the young will be heterozygous dominant whites like one parent, and the other half will be self-blacks like the other parent. It will thus be seen that albinos are recessive to colour, and dominant whites dominant to colour, as the name signifies.

The problem, therefore, was to discover what physical difference underlay this variation in genetic behaviour.

It has been shown that dark animal pigments, or melanins, are in many cases the result of the interaction of an oxydase and a chromogen. The oxydase is generally a tyrosinase, and the chromogen either tyrosine or a closely allied substance. By the union of an organic peroxide and a peroxidase an extremely unstable third substance is formed, which on decomposition gives its oxygen to the colourless chromogen, and thereby converts it into a melanin.

It was found possible to obtain a colourless fluid, rich in tyrosinase,* by making an extract from the skins of very young black rabbits. By adding to this extract a few drops of a saturated aqueous solution of tyrosine as a substitute for the natural chromogen (which appears to be destroyed, together with the organic peroxide, during the process of extraction), and incubating at blood-temperature for twelve hours, the mixture becomes oxidised. A deep black ring forms at the surface of the fluid, where it is in contact with the atmosphere, indicating the formation of melanin. Now, if a fluid is extracted in an exactly similar manner from recessive and from dominant white rabbits,† and if it is incubated with tyrosine in the same way, no darkening occurs. This shows that *either* the tyrosinase is absent, *or*, if it is present, its action is inhibited by some other substance. In order to test this, varying quantities of the two white extracts were incubated with an equal quantity (two cubic centimetres) of an active tyrosinase solution, tyrosine, and hydrogen peroxide. The results were as follows:—

++ Indicates strong reäction.
+ Indicates positive reäction.
— Indicates no change.

	Dominant white extract.	Recessive white extract.	Appearance after 12 hours.
1	—	—	+ +
2	0·05 c.c.	—	+ +
3	0·25 c.c.	—	+
4	0·5 c.c.	—	—
5	1·0 c.c.	—	—
6	—	0·25 c.c.	+ +
7	—	0·5 c.c.	+ +
8	—	1·0 c.c.	+ +
9	—	2·0 c.c.	+‡

* During the process of extraction the organic peroxide component of the peroxidase was usually, but not invariably, destroyed in these experiments. It can, however, be easily replaced by a very small quantity of hydrogen peroxide.

† For this purpose so-called "English" rabbits were used. They are a black-eyed white rabbit with a few coloured spots on the back and flanks.

‡ This reäction was not as strong as the previous ones, owing to the fact that the ferment fluid was diluted by as much as an equal volume of the recessive white extract.

Since no reäction takes place in any of the tubes which contain as much as twenty per cent. of the dominant white extract, and since the tubes containing the recessive white extract are all oxidised, it is clear that the dominant whites are white, because they contain an inhibitor or anti-tyrosinase, which prevents the formation of pigment; and that the recessive whites are white, because at least one factor necessary for the formation of the pigment is absent, namely, tyrosinase. It was also found possible to isolate this inhibitor by fully saturating the fluid extract with ammonium sulphate, when the inhibitor is completely precipitated.

This account of the chemical cause of the difference between dominant and recessive whiteness agrees also with the genetic data; for, as has already been said, ♂ dominant white (with inhibitor) × ♀ self-colour (with colour-producing factors) gives nothing but white offspring; but ♂ recessive white (without colour-producing factors) × ♀ self-colour (with colour-producing factors) gives nothing but self-coloured offspring, as would be expected.

The fact that dominant white animals sometimes have coloured spots or patterns must be explained by the supposition that in these places the inhibitor, for some specific reason, has not been deposited in the skin. No doubt recessive whites are sometimes piebald, for analogous reasons.

The hypothesis that dominant whiteness is caused by the presence of a chemical inhibitor in the cells of the skin, which can be transmitted to the offspring, and which prevents the formation of pigment, is by no means a new one. It was first discovered that certain dihydroxyphenols, such as orcin, had the property of inhibiting the action of tyrosinase upon tyrosine *in vitro*. The dominant white flowers of *Primula sinensis* also contain an inhibitor, which can be destroyed by hydrogen cyanide, after which they will show certain oxydase reäctions with suitable reägents. Certain pale shades of flowers which are dominant over the deeper shades have also been thought to be due to the presence in the petals of deoxidising substances, such as tannin or sugar; and, lastly, the colour of the larvae of *Spelerpes bilineatus* has been modified by subjecting the eggs to a dilute solution of orcin.

FIGURE 125.—A series of tubes containing the skin extracts, and so on, after twelve hours' incubation.

A.—Extract from black rabbits + tyrosine + H_2O_2.
B.—Extract from black rabbits + tyrosine + H_2O_2 at room temperature.
C.—Extract from black rabbits + tyrosine + H_2O_2 + extract from dominant white rabbits.
D.—Extract from chocolate rabbits + tyrosine + H_2O_2.
E.—Extract from black rabbits + *p*-cresol.
F.—Extract from recessive white rabbits + tyrosine + H_2O_2.

C shows no sign of oxidation, because it is inhibited by the anti-tyrosinase in the dominant white rabbits, and F shows no oxidation, because recessive white rabbits contain no tyrosinase. E is coloured deep pink.

Note the layer of unoxidised fluid at the bottom of D, where it has not been in contact with the atmosphere. This layer is not so clearly defined in the other tubes, as they were slightly shaken.

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

MELLISH'S COMET has been observed several times. It has a sharp nucleus, resembling a star, and a considerable coma surrounding it, the diameter being about 10′. Mr. W. H. Steavenson traced the tail for half a degree on April 7th. The orbit given last month needs sensible correction. Perihelion passage will be about July 17·63 G.M.T., and the logarithm of the perihelion distance is 0·0068.

The following outline ephemeris gives an idea of its motion from June to October :—

Date.	R.A.	S.Dec.	Log. r.	Log. Δ.
1915.	h. m. s.	° ′		
June 17·63 ...	4 5 16 ...	67 28 ...	0·0552 ...	9·6655
July 17·63 ...	6 6 56 ...	39 37 ...	0·0068 ...	9·9326
Aug. 16·63 ...	6 26 16 ...	28 21 ...	0·0552 ...	0·0568
Sept. 15·63 ...	6 25 40 ...	21 50 ...	0·1518 ...	0·0860
Oct. 15·63 ...	5 52 52 ...	16 9 ...	0·2466 ...	0·0706

The path is more favourable for northern observers than that given last month. Southerners will enjoy the best of the display, but the comet returns to our zone of visibility in September, when it may still be a naked-eye object.

Winnecke's Periodic Comet returns to perihelion at the end of August, and was detected early in April at the Bergedorf Observatory, its magnitude being 16

STELLAR SPECTRA AND TEMPERATURES.—Messrs. W. S. Adams and A. Kohlschütter write on this subject in No. 89 of the Mount Wilson Contributions. It is taken for granted that the stars of large Proper Motion are on the average nearer than those of small Proper Motion. The latter have the violet end of the spectrum weaker than the former (for the same spectral type); also the hydrogen and a few other lines are relatively stronger in the small Proper Motion stars. The conclusion is that these spectral differences do not arise from absorption in space, but arise from greater atmospheric absorption in stars of large mass. The small Proper Motion stars, being more distant than the others, are presumably of greater mass. Hence there is hope of deducing the absolute mass and luminosity of stars by careful study of the intensity of certain lines, and also the relative strength of different parts of the continuous spectrum. The results have to be considered in combination with the spectral class to which the star belongs.

LATE SPECTRA OF NOVAE.—No. 87 of the same Contributions gives reproductions of photographs of the spectra of 4 Novae taken with the sixty-inch at Mount Wilson by Messrs. W. S. Adams and F. G. Pease. They are : Nova Aurigae, twenty-three years after outburst; Nova Persei, t irteen years after; Nova Lacertae, four years after;

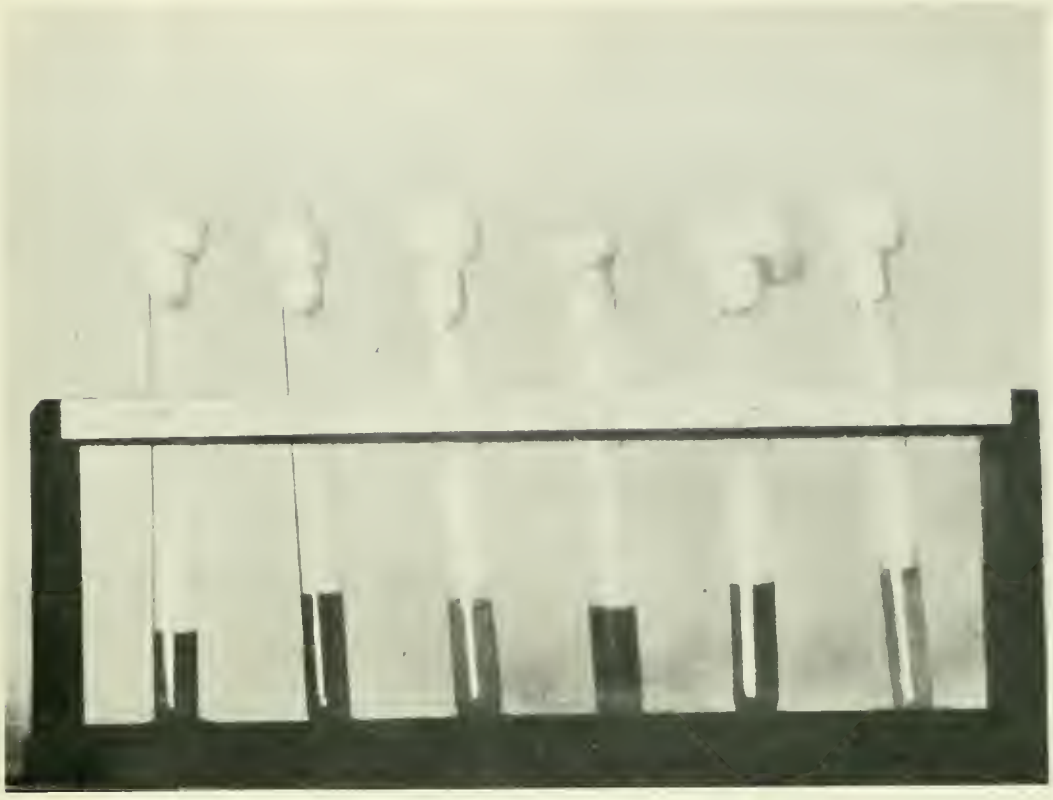


FIGURE 125.
Skin extracts from rabbits (see page 146).

FIGURE 126.
Radula of *Zonites olivetorum* of Moquin-Tandon, stained; in Canada balsam.
× about 140. (See page 152.)

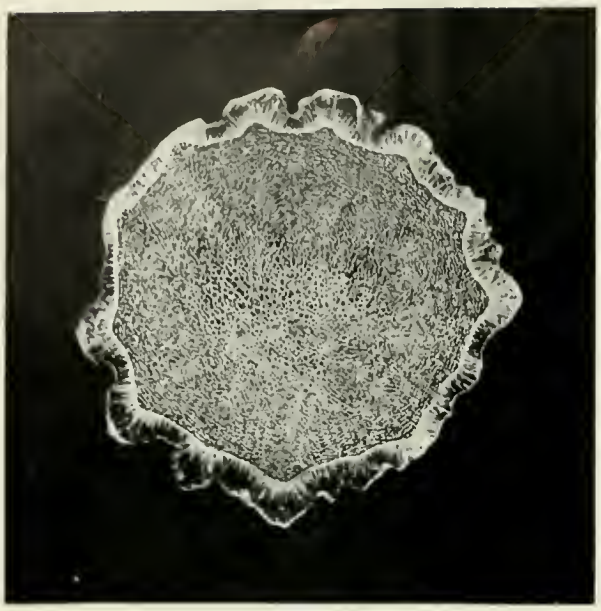


FIGURE 127. Transverse section of the spine of *Cidaris*, taken with a one-inch objective. ×70. Exposure 4 mins.

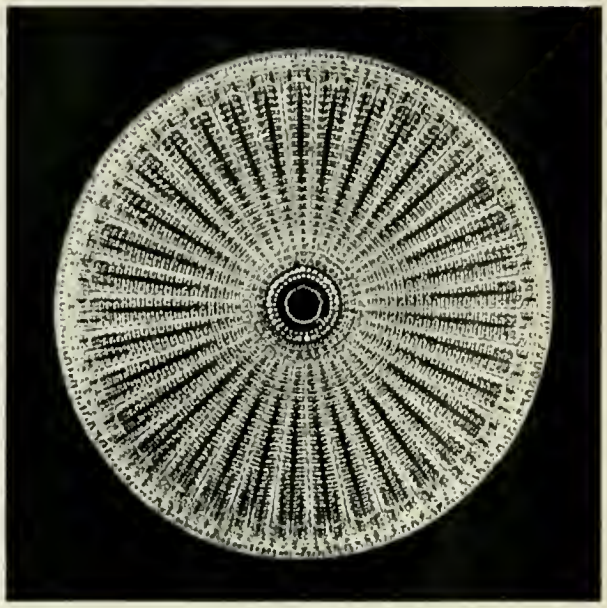


FIGURE 129. *Arachnoidiscus Ehrenbergii*, taken with a half-inch objective. ×280. Exposure 6 mins.

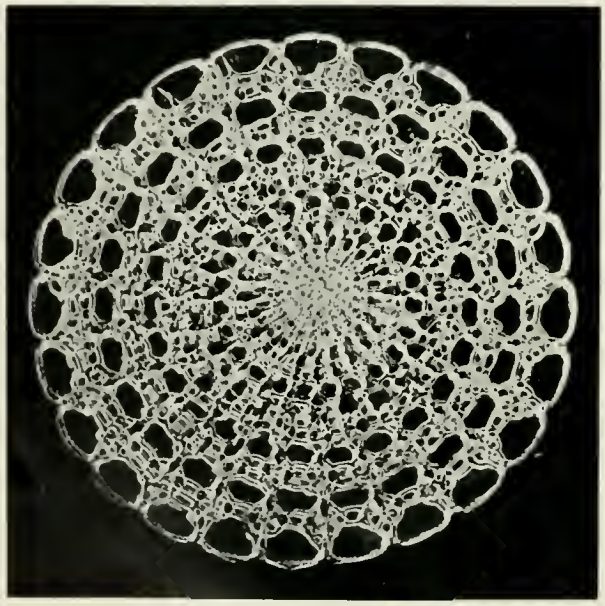


FIGURE 128. Transverse section of the spine of *Echinus*, taken with a two-third inch objective. ×60. Exposure 3½ mins.

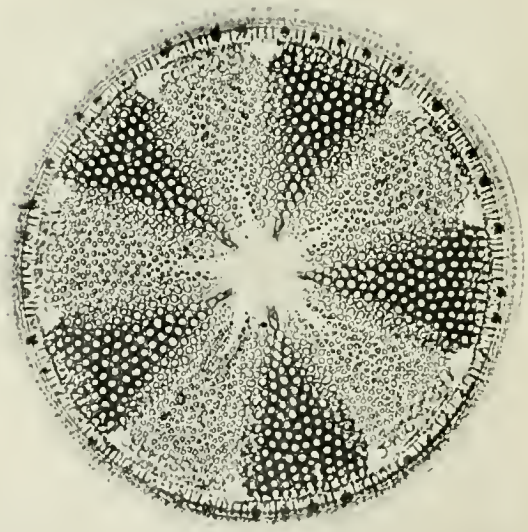


FIGURE 130. *Heliopelta Metii*, taken with a half-inch objective. ×400. Exposure 8 mins.

From photo micrographs by A. Wellesley-Harris, M.R.C.S.,

And illustrating his paper on "Some Hints on Photo-micrography" in *The Journal of the Photo-micrographic Society.*

In all cases, projection ocular No. 4 was used; the illuminant was incandescent gas and the filter, auramine

(see page 153).

Nova (2) Geminorum, two years after. The chief point is that the nebular lines at 4364, 4960, 5007 have completely disappeared in the two older Novae; the last two are still strong in Nova Lacertae, while all three are strong in Nova Geminorum. Hence the fading of these lines is characteristic of the late stage of Novae. At the same time, the continuous spectrum grows stronger. They suggest, in explanation, that the initial outburst is due to the star entering a nebula, and that the nebular lines disappear when the star emerges from it. There is an obvious difficulty in this suggestion. It would need a fairly dense nebular to account for the very sudden outburst of light: such a nebula could hardly fail to be a violent exciting agent during the whole of the star's passage through it. But the above Novae had become very faint before the nebular lines faded out.

The paper points out that the late stages of Nova spectra are almost the same as those of Wolf-Rayet stars. It is suggested that at least some of the latter stars may have once been Novae.

THE COLLISION HYPOTHESIS OF NOVAE.—Mr. F. A. Lindemann has an article on this subject in *Monthly Notices* for January. Examining whether collision with a nebula would explain the observed phenomena, he finds that the pressure of the nebula would have to be about 1/1000 of a millimetre—Mr. Ranyard had shown that so high a density is improbable. The objection is also made that the temperature would increase, or at least remain constant, all the time that the star was traversing the nebula; but in fact the decline generally sets in very soon. The hypothesis of collision with a meteor swarm is more hopeful; but the author thinks that in this case it would return rapidly to its condition before the outburst, whereas the effects on the spectrum persist for many years. He next deals with the assumption that novae arise from the collision of star with star. Making the best assumptions in his power for the various constants involved, he deduces that the number of dark stars in our system must be about four thousand times the number of bright ones. If this be correct, stars remain dark for a much longer period than they are luminous. The period of luminosity of a star is supposed to be measured by hundreds of millions of years, and its dark period would be measured by billions. Such matters must always remain highly speculative; still, they have a fascination for many minds, and the time spent on them is not wasted.

THE SOLAR ECLIPSE OF LAST AUGUST.—*Monthly Notices* for January contains the reports of the observers, with two photographs and a careful drawing, which shows that the corona was of slightly modified minimum form, differing in the fact that the equatorial streamers were more spread out than at minimum. Father Cortie obtained a successful photograph of the coronal spectrum. Five series of flutings were shown, three in the red and two in the green; also several lines, including the characteristic line in the green at 5303. The sources of the other lines have not yet been identified. The photographs at Minsk failed to show the 5303 line, and indicated that the violet end of the coronal spectrum was unusually faint. The spectrum of the chromosphere was photographed down to wave-length 3118 in the ultra-violet. Both the Minsk observers and Father Cortie took an iron comparison spectrum on their plates, so that accurate measures of wave-length can be made. On the whole, considering the disturbance due to the war, the observation of the eclipse was successful; some of the Russian, French, and Swedish observers also obtained good results. In particular they discovered a new bright line in the red part of the coronal spectrum at wave-length 6374: this is included in one of Father Cortie's bands.

THE ANNUAL REPORT OF THE ROYAL ASTRONOMICAL SOCIETY contains several interesting notes on the progress of astronomy. Controversy over the solar constant of radiation continues. Messrs. Abbot, Fowle, A. K. Ångström, and E. H. Kennard support the low value of 1·93 calories per cm.^{2} sec., while F. W. Very maintains that it cannot be less than 3, and may reach 4. He considers that much heat is reflected from the upper air without reaching the Earth.

F. Schlesinger gives the formula $14°{\cdot}17 - 3°{\cdot}4 \sin^2\phi$ for the daily solar rotation, ϕ being the latitude. This is deduced from spectroscopic measures in the regions of the spectrum 4059 to 4126, and 4220 to 4277.

The solar activity is now definitely on the up grade, and equatorial spots have died out, showing the demise of the old cycle.

Mr. D'Esterre has continued his photographic and visual patrol on selected regions of the Milky Way, and has discovered many new faint variables. He had previously stated that no known variable had a fainter minimum than the eighteenth magnitude. He has now found four whose minima lie between the eighteenth and the nineteenth magnitude, and one that goes down to the twenty-first.

The Transit Circle at Greenwich has been fitted with a travelling-wire micrometer for observing transits. This will make a minute alteration in Greenwich time, as the "personal equation" of the old method will disappear. It is found that all observers practically agree in their observations on the travelling method. During a transit the observer continually turns two handles, so as to keep the star bisected by the travelling wire. Contacts are made automatically when the wire passes certain points in the field.

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

SEEDS OF WATER PLANTS.—It has been stated by different observers that the seeds of some aquatic plants do not germinate without first being dried; others have found that the passage of such seeds through the alimentary canal of birds greatly improves their power of germinating; while it has been found that acids and alkalies arouse many water-plant seeds from their dormancy. A closer investigation of the peculiarities of the seeds of aquatic plants has recently been made by Crocker and Davis (*Bot. Gazette*, Volume LVIII), who have dealt with the water plantain (*Alisma plantago*), but consider that their results probably apply to water plants generally. They have studied in this plant the structure and microchemistry of the seed-coat, the water relations of seed and embryo, the effect of acids on the rate of intake of water by the embryo, imbibition and growth elongation of the embryo, elasticity of the seed-coat, and oxygen pressure in relation to the germination of the seed and the formation of chlorophyll in the seedling. They point out that delayed germination (longevity) of seeds is secured in different ways in different cases: by almost complete exclusion of water in the hard-seeded Leguminosae and other seeds capable of remaining dormant for very long periods; by limiting the degree of swelling of the embryo by surrounding structure, as in *Alisma*, and probably other water plants; by reduction of oxygen supply below the minimum necessary for germination, as in various Compositae, some grasses, and so on, and perhaps by deficiency of salts. To these must be added delays due to embryo characters, as slowness of acid development in the embryo of hawthorn, apple, and other Rosaceae. All these possibilities should be considered in studying the mechanics of delayed germination, instead of assuming, as some writers have done, that injury to the seed-coat or the action of light must act as a stimulus, and that dormancy is therefore determined by the characters of the embryo alone. In the case of *Alisma* the authors conclude that dormancy is due to the mechanical restraint of the seed-coat, which enables the seed to lie in water for years without germination. As the intact achene lies in water in the saturated state the embryo itself does not consummate more than one-fourth of its possible imbibitional and osmotic swelling and in the

partially swollen state remains for years in water restrained in its swelling by the seed-coat against which it exerts a pressure of about one hundred atmospheres. When the seed-coat is removed the embryo continues its swelling, which gradually passes into growth enlargement. The pectic substances of which the coat almost entirely consists are readily hydrolysed by weak acids and bases, which also change the water relations of these substances, as in the case of water-absorbing colloids generally. Acids increase slightly the imbibitional force of the embryo, while bases increase greatly the rate of elongation of the embryo. The effect of acids and bases on the germination of Alisma seeds is largely due to weakening of the seed-coat, so that the swelling embryo can break away the coat-cap at the larger end of the seed. The points of most obvious ecological importance are that the seeds of Alisma, and probably those of water plants generally, are capable of lying in water for years in the imbibed condition without losing their vitality, whereas those of land plants can only withstand such storage for a short time; and that the embryo is capable, at the expense of its stored food alone, of considerable growth in total absence of oxygen, though it requires oxygen for development of chlorophyll and a larger supply for branching and the development of the primary root.

THE FLOWER OF *PARNASSIA*.—The flower of *Parnassia* (Grass of Parnassus) shows, as is well known, a remarkable peculiarity in the form of a series of five candelabra-like structures, one within each of the five petals, alternating with the five stamens. These structures are regarded as sterile stamens (staminodes): each has a solid honey-secreting base, and each of the branches into which it divides above this ends in a yellow knob, glistening in the light and looking like a drop of honey, though it is a solid body. Flies, deceived by this appearance, have been seen licking the knobs. The genus *Parnassia* has hitherto been placed in the Saxifrage family, though the resemblance between its staminodes and the stamen-bundles in the flower of St. John's Wort (*Hypericum*) has led some writers to regard *Parnassia* as related rather to the *Hypericum* family. For instance, in some species of *Hypericum* each anther contains a gland, and, if the pollen-sacs of these anthers were to become abortive, we should be left with a bundle of filaments, each ending in a gland, exactly like the staminodes of *Parnassia*. Mrs. Arber (*Annals of Botany*, Volume XXVII) has investigated the structure of the *Parnassia* flower in detail and has, found that each stamen contains, in addition to the usual single vascular bundle present in stamen filaments, distinct traces of a number of other bundles in a reduced or vestigial condition; hence the fertile stamens agree with the staminodes in showing several bundles, though in a vestigial condition. She also finds that the bundles destined for the stamens arise at a lower level in the receptacle than those which go into the staminodes, confirming the view that the staminodes represent the inner whorl of the androecium. It is suggested that the peculiarities in the anatomy of the stamens of *Parnassia* indicate that each individual stamen is reduced from an ancestral stamen-bundle like that of *Hypericum*, and that the two genera are closely related; also that *Parnassia* should be placed in a separate family instead of being classed in the Saxifragaceae.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

COLOURS OF FLOWERS AS INDICATORS.—An interesting study of the behaviour of the colouring matters of flowers towards acids and alkalies is published by Mr. H. W. Brubaker in the *Journal American Chemical Society* (1914, XXXVI, 1925). The petals of most flowers, especially those of blue, red, pink, and purple tints, are changed in colour by alkalies, while acids restore the original colour or produce some shade of red. The yellow pigments, however, are unaffected by either acids or alkalies, whereas white flowers (white rose, pansy, clover, geranium) are changed to yellow by alkalies, and back to white again by acids. The reds and purples are turned to green or greenish-blue by alkalies, while the original colour is restored or intensified by acids.

As a rule, these colouring matters are of an acid character, and are less frequently neutral. They appear to be closely related to one another, and it would seem that the different variations in the colour of a certain flower or species of flowers are the results of slight chemical changes in the original pigment.

So sensitive are some of these colouring matters to the action of alkalies and acids that they can be used as chemical indicators. For example, the red colouring matter of the rugosa rose (*Rosa rugosa*) can be extracted with alcohol, and the purified solution is turned green by alkalies, while the red colour is restored by acids, and the liquid becomes colourless at the point of neutrality. The indicator is sensitive to carbonic acid, and changes colour in a solution of sodium hydroxide, containing only one part in twenty-five thousand. The colouring matters of the perennial pea (*Lathyrus latifolius*), iris, and purple vetch behave in an analogous manner, and appear to be either identical with, or closely allied to, the pigment of the rugosa rose.

CHARACTER OF CREOSOTE IN PRESERVED TIMBER.—Most of the preservatives for timber are composed of a basis of creosote, to which is added tar or coloured pigments to meet the popular taste. These preparations differ greatly in their preservative action, and considerable light is thrown on the causes of these differences by an investigation of Mr. G. Alleman (*Proc. Amer. Wood Preservers' Assoc.*, 1914, page 88).

The creosote oils extracted from well-preserved timber that had been in use for several years were found to contain, on the average, 32·9 per cent. of constituents boiling below 270° C. and 66·8 per cent. of constituents of high boiling-point. It is to a deficiency of the latter that the defects of many modern creosote preservative must be attributed, for the heavy constituents have much greater penetrative and water-proofing capacity than the light oils.

As the result of the experiments the conclusion is drawn that for general purposes at least fifty per cent. of the oil should distil above 315° C., and for treating pavement blocks not less than sixty-five per cent. The penetrating power of tar is small, even when injected at a high temperature, and when a mixture of tar and creosote oil is employed separation of the components may be observed towards the margins of close-grained rings in the wood. In the case of light creosote oils loss is inevitable owing to volatilisation, extraction of the oil by rain, and crystallisation within the wood. The preservative effect of creosote appears to depend partly upon antiseptic action and partly upon the interior cell walls of the wood becoming coated with a stable film of the oil, which excludes moisture. Light oils are rich in antiseptic substances; but, as these are soluble in water, they are soon washed out of the wood by the rain.

GEOGRAPHY.

By A. SCOTT, M.A., B.Sc.

INTERGLACIAL GORGES.—In those parts of the world which show evidence of recent glaciation there is generally considerable doubt as to the number of ice-invasions. Such tests as the relative erosion of drift-materials of different ages, or the amount of interglacial cutting by streams whose profiles have been "de-graded" by ice-action, are often difficult to apply. In the latter case, the tributary streams may show several outlet gorges into the main valley, which has passed through successive stages of over-deepening. The number of gorges should give the minimum number of interglacial periods, but not the maximum, as there is nothing to hinder the re-excavation of the old gorges. The width of the different gorges, con-

sidered in relation to the gradient and discharge of the streams, should indicate the relative duration of the interglacial periods.

Evidence of this nature has been obtained by Rich and Filmer (*Jour. Geol.* January-February, 1915) in the case of Six-mile Creek in New York State. Numerous moraines, a typically glaciated cross-section, and a floor hanging 450 feet above that of the main valley are certain evidence of the intense glaciation this creek has undergone. In the valley-bottom are three distinct gorges, two of them being preglacial and the third postglacial. The earliest gorge is clearly subsequent to the adoption of the U-shape by the valley, but is apparently antecedent to two later glaciations. Hence, it may belong to the first interglacial period. The second gorge, cut in the floor of the first, is later than the ice which filled the latter with drift, but the presence of striae on the walls shows it to be earlier than the third glaciation, so it belongs to the second interglacial period. The third gorge is cut through the material deposited during this last ice-invasion, and there is no evidence of any subsequent ice-action. An alternative explanation is the possibility of an origin by rejuvenation, but there is no evidence of such a process in any of the adjacent streams.

TRANSPORTATION OF DÉBRIS BY RUNNING WATER.—An elaborate account, accompanied by diagrams and tables of data, of numerous experiments on the transportation of débris by running water is given by G. K. Gilbert in one of the U.S. Geological Survey publications (Prof. Paper 86). While a considerable amount is known concerning the material carried in suspension by streams, very few facts have been ascertained about the "bed-load" or material swept along the river-bottom. In the experiments described, specific loads of sand and gravel are fed into artificial streams of known discharge, and measurements taken of the effects of the various factors. It is found that for each set of conditions there is a definite gradient below which no load is transported, and that this slope varies with the grain size of material. The variations in the "capacity," *i.e.*, power of transport, due to discharge and grain size are of a lower order of magnitude than those due to slope. The majority of the particles are transported by a process of "saltation," or leaping, though the larger ones show a tendency to roll. With small bed loads, transportation takes place by the down-stream migration of mounds of material, very much like the advance of sand-dunes under aeölian conditions. As the load increases, the surface first becomes smooth, and then "antidunes" form, with an up-stream migration of the crests. Numerous formulae are deduced, but the application of these to actual rivers must be made with extreme care, owing to the great variation, with different conditions of load, discharge, and so forth.

COMMERCE AMONG THE ESKIMO.—In the past, trade between the various Eskimo tribes has been conditioned by the feasibility of the routes and the resources and distribution of the tribes. The chief highway is the sea, not, however, as water, but as ice. The short season when there is open water is entirely taken up by harvesting and hunting, so that trading is relegated to winter and spring. Until recently, sled journeys from Alaska, even to the Siberian side of the Behring Sea, were common. The chief trading route between the Mackenzie Delta and Hudson Bay lies along the coast as far as Cape Parry, turns northward to Nelson Head, and then eastward through Prince Albert Sound, and across Victoria Island. From there it runs due south for three hundred miles to the head of Chesterfield Inlet, and finally down the latter to Hudson Bay. Another route, now disused, keeps close to the coast of the mainland, and passes through Coronation Gulf. The speed of such a journey may be judged from the fact that the minimum time necessary for an article from Alaska to reach Hudson Bay is two and a half years, while the average time is probably nearer five years. The Behring communities transport Siberian goods, such as ivory, blubber, and oil, eastward and receive in return skins and stoneware. A full account of the articles which the various tribes deal in is given by Stefansson (*Can. Geol. Survey, Museum Bulletin No.* 6), and the dependence of these on resources, routes, and so on, is discussed at some length.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

ORIGIN OF CHINA CLAY.—The origin of this important economic product is dealt with in considerable detail in a Handbook to the Collection of Kaolin, China Clay, and China Stone in the Museum of Practical Geology, written by Dr. J. A. Howe, and published by the Geological Survey. The great West of England occurrences are fully described, along with the methods of obtaining the clay and preparing it for use. Other occurrences at home and abroad are next described. This is followed by chapters dealing with china stone, the uses of china clay and china stone, the mineral kaolinite and its allies, and the various theories of origin that have been propounded from time to time. The last two chapters contain statistics of production and a list of the china clay works of the West of England. An excellent appendix by Mr. Allan Dick describes the microscopical characters of kaolin and the delicate methods of investigation used for this and similar substances. The handbook runs to 271 pages, and is an excellent and most interesting production

The principal hypotheses put forward to account for the production of kaolin (mainly from felspars and felspathic rocks) are based on the action of the following agencies: (1) Surface weathering; (2) waters descending from swamps and bogs; (3) ascending waters containing carbon dioxide; (4) emanations following igneous activity; (5) sulphuric-acid solutions and hydrogen sulphide; (6) hydrolysis.

The question of origin is of especial interest in connection with the rich deposits of the West of England. These are associated with the great granite intrusions of that area, especially those of St. Austell, Bodmin Moor, and Dartmoor The hypothesis that surface weathering is the chief agent of kaolinisation is the oldest, and still holds pride of place in the textbooks; but there are insuperable objections to it in the case of the West of England deposits. It is difficult to explain the extremely local distribution of the kaolin on this hypothesis. One would expect it to be a common and widespread superficial deposit in most granites if it were due to surface weathering. Moreover, granite frequently weathers to considerable depths, but with the formation of material very different from china clay. The theory which ascribes the origin of the West of England china clay to the heated gases and liquids accompanying or following igneous intrusion (pneumatolysis) finds much support from the observed facts. The localised occurrence of the kaolin and the fact that the kaolin bodies appear to become more extensive downwards find ready explanation on this theory. Moreover, the kaolin is frequently associated with topaz, fluorite, and cassiterite—minerals which are known to have been formed by emanations containing boric and hydrofluoric acids. Dr. Howe shows that it does not necessarily follow that kaolin is due to the action of these particular acids on the felspars of the granite, but he, nevertheless, accepts the view that kaolin is due to some kind of pneumatolytic action, and is inclined to consider that carbon dioxide, always an important emanation product, is the chief agent in the process. He points out that the operation of this factor is not excluded in any of the described occurrences of kaolin, and is accepted by exponents of all theories alike. Its activity is recognised in the later phases of pneumatolysis, in ordinary weathering and the action of peaty waters, in the action of hot or cold spring waters containing the gas, and also in the process of hydrolysis.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

THE WEATHER OF MAY.—The month of May is generally characterised by a great increase of warmth and sunshine, while the still increasing power of the Sun's rays manifests itself by the rapid advance of vegetation. May is, however, subject to great vicissitudes of temperature, and sometimes sharp frosts occur at night, which seriously injure the fruit and cereal crops.

"Till May be out
Leave not off a clout."

May was a very cold month in the years 1845, 1855, 1856, 1877, 1879, 1885, and 1902; and it was very warm in the years 1841, 1848, 1865, 1868, 1893, and 1895.

The average mean temperature at Greenwich for May is 53°·0; in 1848 it was as high as 59°·7, while in 1879 it was as low as 48°·6. The average maximum temperature is 63°·9; the highest mean was 73°·3 in 1848, and the lowest 57°·3 in 1902. The average minimum temperature is 43°·7; the highest mean was 48°·3 in 1841, and the lowest 39°·2 in 1876. The absolute highest temperature recorded was 87°·5 in 1880 on the 26th, and the absolute lowest was 28°·1 in 1877 on the 4th. The latest date on which a temperature below 32° was registered was on the 24th in 1867.

The average rainfall for the month of May is 1·95 inches; the greatest amount was 4·37 inches in 1865, and the least 0·25 inch in 1833. The heaviest fall in one day was 1·40 inches in 1825 on the 13th. The average number of "rain days" (*i.e.*, on which 0·01 inch fell) is 12·4; the greatest number of days was twenty-two in 1902, and the least three in 1848. The average amount of bright sunshine at the Kew Observatory, Richmond, is two hundred hours.

The average barometric pressure in London for May is 29·969 inches; the highest mean was 30·227 inches in 1896, and the lowest mean was 29·790 inches in 1891.

CYCLONES AND ANTICYCLONES.—It will be remembered that it was proposed to hold a Meteorological Conference in Edinburgh in September last, but owing to the war it had to be postponed. Two or three papers which were to have been read at the Conference have now been printed in *The Journal of the Scottish Meteorological Society*. One of these, on "Cyclones and Anticyclones," is by Mr. W. H. Dines, F.R.S., and in this he points out that the old convectional theory of the cyclone, known as "Ferrel's Theory," is utterly untenable in view of recent knowledge. Observations obtained by means of registering balloons have led to the definite conclusion that the lower strata of the atmosphere are relatively cold in cyclones and relatively warm in anticyclones. The statistical treatment of the observations has led to certain other conclusions, and shows that there is a very intimate connection between the temperature and the pressure of the upper air, but that, except close to the surface, there is very little connection between the temperature of the air and its direction or rate of motion. The importance of the pressure at a height of about nine kilometres is demonstrated, and an explanation is given of the way in which the temperature conditions in cyclones and anticyclones follow naturally from the distribution of pressure of nine kilometres. Mr. Dines further points out that the effect of radiation is of secondary importance in altering the temperature of the air.

TORNADO IN WALES, OCTOBER 27TH, 1913.—Reference was made in "KNOWLEDGE" (Volume XXXVI, page 465) to the remarkable storm of a tornado type which occurred in South Wales on October 27th, 1913. The Meteorological Office has published, in *The Geophysical Memoirs*, a report on this tornado by Mr. H. Billett, who spent three days in visiting the greater part of the region affected by the storm. A system of violent meteorological phenomena passed along a line running almost due north from the south of Devon to Cheshire, between 3.45 and 9 p.m. There appear to have been four main regions of action in its path, namely, (1) South Devon, (2) South Wales, (3) Shropshire, and (4) Cheshire; the most violent was that in the Taff Valley. One of the most remarkable features of the storm was the sharpness of its boundaries on either side of its track. Practically no damage was done outside the narrow limits of the course, which nowhere exceeded one thousand feet in width. The tornado was accompanied by very severe lightning and torrential rainfall, and reached its greatest force at Abercynon and Edwardsville, where five deaths occurred. The storm was circular in shape; and, as it progressed with a speed of thirty-six miles per hour, its duration at any place, assuming the width of the track within which damage was done to be three hundred yards, works out at seventeen seconds. The evidence collected shows that the storm was a genuine tornado of the type common enough in parts of America, but fortunately of rare occurrence in this country.

MIRAGE ON THE CORNISH COAST.—Mr. P. H. Horton in a letter to *The Times* gave a graphic account of a curious phenomenon which he saw from the Cornish coast at Mawnan, a few miles from Falmouth, for about half an hour on the afternoon of October 24th. In a shallow cloud-bank, stretching across the horizon from south-east to south, there gradually appeared what seemed to be a line of coast, with woods, trees, fields, hedges, and houses in their natural colours. At first he thought it was merely a peculiar arrangement of clouds, but soon he recognised that it was a complete reflected panorama of the coast, and he gradually identified St. Keverne, with its church spire, the Helford River, Mawnan Church, Rosemullion, Falmouth Harbour, and St. Anthony. Shortly before the whole scene faded away a reflection of Pendennis Head, with the Castle and the military huts, emerging like some huge ship from a fog bank, appeared most distinctly, and was visible for several minutes. Every detail of the whole scene was reversed as in a looking-glass, and slightly magnified; for, although the panorama seemed to be some twenty miles away, everything appeared as it would to an observer from the distance of only a mile or so. The colours were a little less bright than those of the real coast at the time. Mr. Horton adds that the scene, as a whole, was visible all the time, but the details of a small portion only were quite distinct at any one time, commencing in the south and gradually moving towards the east, the effect being that of a powerful searchlight being very slowly turned from right to left on to the opposite shore of a large lake.

MICROSCOPY.

By F.R.M.S.

NEW METHOD OF STAINING RADULAE.—Figure 126 on page 147 shows the radula of *Zonites olivetorum* of Moquin-Tandon, of which I took several specimens in August, 1897, near the top of the Col de Tillet (Hautes-Pyrénées). We have no British form with a radula of this type, but it may be compared to *Polita nitidula*. The figure is introduced here in order to show the advantage gained by staining the radula with a suitable stain and mounting in Canada balsam, the refractive index of which is nearly the same as that of the chitin of the radula, while it is also in correspondence with the optical system of the microscope. Thus the picture seen on the stage is entirely due to the stain, and contains no fallacious shadows representing difference of refractive indices. The resolution in depth is the maximum possible without distortion of the elements of the picture. The photograph was taken with an objective of N.A. 0·18, and the structures are large.

The method adopted is as follows:—

(1) Boil out the radula with one or two per cent. caustic potash, wash, and neutralise with dilute acetic acid.

(2) Arrange the radula on the slide, after clearing away the adherent membranes, *i.e.*, the lining of the odontophore sac.

(3) Cover the radula with a drop of acidified permanganate solution. The best formula for use will vary with circumstances, but that employed in the making of autochromes serves very well. The unci—and, to some extent, the whole membrane—are now seen to turn yellow, brown, and, finally, black.

(4) Now wash off the permanganate, which has fulfilled its oxidising function, with distilled water.

(5) Cover the radula with a drop of oxalic-acid solution, which will gradually decolorise it, with evolution of CO_2.

(6) Wash thoroughly with distilled water and again soak in dilute acetic acid.

(7) The radula can now be stained in a weak solution of dahlia in one per cent. acetic acid. The advantage of using a weak solution is that the progress of staining can be watched; but overstaining does not very readily occur, because the oxidation is limited to the external layers of the chitin, and thus a transparent effect can be obtained.

(8) Dehydrate, clear in oil of cloves, and mount in xylol balsam.

Though this process seems long, it is, in reality, quite simple and easy, and the effect can be seen at each stage, so that there need be no doubt about the final result if the operations are conducted with reasonable care. Such a preparation may be regarded as permanent: it requires no ringing. Some other stains can be used in place of dahlia, but I have not yet found any equally satisfactory. The object looks bluish-violet by daylight and violet-red by lamplight. It is easily photographed on the Ilford chromatic plate with a yellow or green screen. Personally I prefer the latter, as giving a little more contrast. The full aperture of the objective (if it is of a good make) can be used.

Hydrolysis of the chitin also may be brought about by various reagents, and renders the radula permeable to many stains, such as acid fuchsin, indigo carmine, and brilliant black. The various methods of inducing hydrolysis which I have tried have, however, been much more uncertain and tedious than the superficial oxidation process described above. E. W. BOWELL.

THE PHOTOMICROGRAPHIC SOCIETY.—In the year 1911 the Photomicrographic Society was started, and since that time it has been actively at work. The ordinary meetings are held at King's College Bacteriological Laboratories, 62, Chandos Street, London, W.C., at 8 p.m., on the second Wednesday in the month, from October to May inclusive. At these gatherings visitors are welcomed. There are, besides, "members' evenings"—usually on the fourth Wednesday in the month—for members only. Hitherto the proceedings of the Society have been issued, but they have not been printed. Now we are able to welcome them in type as *The Journal of the Photomicrographic Society* (price to non-members, 3s. 9d.). The present instalment contains an account of several ordinary meetings, and the papers read at them, including one by Mr. J. E. Barnard, on "Colour Screens." This should be of particular use to those who are photographing through the microscope, as it is most practical. The absorption spectra of some of the filters are given as plates. There is also a paper, by Mr. Martin Duncan, on "Studies in Marine Biology," and one, by Mr. C. A. Bunnin, on "Colour Sensitive Plates and their Uses." Beginners in the work will find Mr. Wellesley Harris's "Hints on Photomicrography" most helpful. The success which Mr. Wellesley Harris obtains with the methods which he uses and describes can be gathered from the illustrations, which we have been kindly permitted to reproduce on page 148, and as in his paper he gives very full details as to lighting, lenses, camera extension, and so on, he makes it all the easier for those who take up photomicrography to follow in his footsteps. We might add that the subscription to the Society is seven shillings and sixpence for the session, and includes two issues of the Society's Journal. The Honorary Secretary is Mr. J. E. Bradbury, 1, Hogarth Hill, Hendon, N.W. W. M. W.

HAIRS OF THE LARVA OF AN *ANTHRENUS*.—On unpacking a small consignment of insects from Natal I found amongst them the living larva of a coleopterous insect, probably that of an *Anthrenus*. Shortly afterwards it entered the pupa state, and in due course a small beetle about one-ninth of an inch long was developed. The

FIGURE 131.

thorax and elytra of this were covered with beautiful scales, white, dark brown, and orange-coloured, arranged in symmetrical patterns. Having mounted the exuvium in Canada balsam, I found, on careful examination, a considerable difference between it and that of the species only too well known to insect collectors in this country. The body in each case was covered with delicate pointed hairs, the majority of which were fringed throughout their entire length by minute secondary hairs (see Figure 131*c*), but from the margin of each segment, except the first and last, in the Natal species there extended a large number of spear-headed hairs (see Figure 131*b*), somewhat similar to those which used to be mounted and sold under the name of "Hairs of the larva of *Dermestes*," although it is well known to entomologists that the genus *Dermestes* does not possess them. In the English variety these hairs (see Figure 131*d*) were only to be found near the tail. A comparison between them showed that those of the former were smaller, and that the whorls with which the shafts were adorned were closer together and less prominent, whilst the heads of the spears differed in shape at their bases, and were proportionately longer, though not quite so broad. Two dense tufts, each consisting of not fewer than two hundred hairs, proceeded from the lateral margins of the last segment but one, and extended much beyond the last segment itself. The feet in each case carried a single claw, but those of the English species (see Figure 131*e*) were larger and stronger than those from Natal (see Figure 131*a*); the mandibles in each case were similar in size and shape. A still smaller beetle from China, obviously an *Anthrenus*, is covered with black scales of the same shape as those of the Natal species. R. T. L.

THE QUEKETT MICROSCOPICAL CLUB.—At the five hundred and sixth ordinary meeting of the Club on Tuesday, March 23rd, Mr. C. D. Soar read a *résumé* of a paper by Mr. Williamson and himself on "British Hydracarina, genus *Lebertia*." Mr. J. W. Gordon showed and

described an objective that had been made for him by Messrs. Beck in 1909. It is a half-inch dry lens, fitted with a front carrying an oil-immersion lens. It was described in the catalogue of the Optical Convention in 1912. Its properties and advantages were explained. They resembled those obtained with high-power immersion lenses, and which had previously been considered to be obtainable only with powers of one-eighth inch or one-twelfth inch.

A paper by Mr. Harris on "Microscopical Methods in Bryological Work" was read by Mr. F. J. Perks. It discussed various media suitable for mounting mosses, with the methods that should be employed in order to display the structure as well as the whole plant.

For tickets of admission to the meetings, application should be made to the Honorary Secretary, Mr. James Burton, 8, Somali Road, West Hampstead, N.W., or to any of the leading London opticians.

J. B.

PHOTOGRAPHY.

By EDGAR SENIOR.

MAKING NEGATIVES READY FOR PRINTING.—Apart from retouching, a great deal can be done to improve the printing qualities of a negative by the expenditure of a little time upon each one. After drying—which operation should be carried out as far as possible in an even temperature, and should not occupy more than three or four hours—the negative should be examined carefully for any defects, such as pinholes, air bells, scratches, and so on, and these should be carefully touched out by means of a fine sable brush and water colour. Almost any pigment which will not allow the chemical rays to be transmitted will answer the purpose; thus Indian red or carmine have both been largely employed, as well as a specially prepared substance known as "Gihon's opaque." A common mistake with beginners when spotting is that they use the colour too thin, when, in the case of a transparent spot, the colour runs round the hole, and leaves the centre bare, and this has afterwards to be filled in. The trouble may also arise from the use of too large a brush. The colour must not only be used as dry as possible, but should be applied with a very small sable brush, such as a $\frac{3}{0}$ of Newman, or a series 15 of Winsor & Newton—camel-hair is useless. Pinholes can, as a rule, be spotted out by a single touch, whereas large spots, such as those due to air-bells, require to be filled in by means of a succession of small touches, applied in such a manner as to bring the density up as nearly as possible to that of the surrounding parts of the image. Scratches on the film, if only surface-formed, can very often be obliterated by means of a finely pointed pencil. When the sky in the negative of a landscape or architectural subject is defective, it is often better to block it out completely. This may be accomplished as follows. Make a rough print from the negative on P.O.P. paper, and cut out the sky portion at a distance of about one-sixteenth of an inch above the outline of the landscape portion. The sky of print is then exposed to daylight to blacken, and while this is taking place the outline of the sky on the negative is blocked out for about a quarter of an inch all along. The sky portion of the print having become blackened is now used as a mask by attaching it to the negative—on the film side—by means of a few touches of gum. The slight amount of trouble taken in painting out round the outline of the landscape is more than compensated for in allowing the sky mask to be more or less roughly cut out; and, besides, no matter how accurately this may have been cut, it is not easy to fit it to the negative when the outline of the subject is at all intricate. In the case of architectural or other subjects in which there may be a series of straight lines, it is often found very difficult to outline these with a brush without producing the appearance of a broken or wavy line. A better plan would be to use a drawing-pen and a straight-edge, and charging the pen with Indian ink, to hold it vertical or at right angles to the negative, and without bearing too heavily upon it, proceed to draw a good thick line along those parts of the building having straight lines standing out against the sky, and then, afterwards, with the brush proceed to fill in any little corners where the drawing pen could not be used. Having outlined the whole, the entire surface of the sky may now be gone over with the brush, bringing it just to touch the lines made by the drawing-pen, by this means completing the blocking-out of the sky or background.

EMPLOYING USED FERROUS OXALATE DEVELOPER.—It may be of interest to some to know that ferrous oxalate developer that has been used, instead of being thrown away, may be employed to provide potassio-ferric oxalate, this substance being the basis of one of the best reducers, which is known as "Belitski's reducer." All that is necessary is to place the used developer in a dish, so that it is freely exposed to the air, when the emerald-green crystals that are deposited are collected and rinsed in cold water, to free them from any oxide of iron which may adhere to them. This being done, the crystals are dried on filter paper, and placed in a well-stoppered bottle, and kept in the dark, as potassio-ferric oxalate is somewhat sensitive to light. In order to prepare the reducing solution, thirty grains of the salt are dissolved in half an ounce of water, and then mixed with half an ounce of the fixing bath containing four ounces of "hypo" dissolved in twenty ounces of water. The negative which requires reducing is placed in the solution contained in a dish, which is kept rocked during the operation. Reduction soon commences, and proceeds regularly, and when finished is followed by a thorough washing under a stream of water, which completes the operation. When done with, the solution is thrown away, as the mixed solutions do not keep.

PHYSICS.

By J. H. VINCENT, M.A., D.Sc., A.R.C.Sc.

DETERMINATION OF TEMPERATURE BY MEASURING RADIATION.—The temperature of a source of radiant heat, such as the interior of a furnace, may be deduced from observations on the radiations which it gives out. If one assumes that the interior of the furnace behaves as an ideal black body, as will be the case if the observation is carried out through a small break in the enclosure to the furnace, then by Stefan's law the total radiation is proportional to the fourth power of the absolute temperature. The radiation can be concentrated on to the surface of some form of bolometer, or on to a thermopile, by means of a mirror or lens; and the instrument can be calibrated by the use of sources of known temperature. The Féry radiation pyrometer is an instrument of this class. It consists of a reflecting telescope, which is pointed at the interior of the furnace through a hole in the wall. After reflection from the face of the concave mirror the radiation falls on a thermo-couple placed at the conjugate focus to the hole in the furnace wall, and thus situated between the face of the mirror and the hole. On the other side of the mirror is an eyepiece by means of which the observer looks through an aperture in the centre of the mirror, and adjusts the image of the opening in the furnace until it slightly overlaps the disc which forms the absorbing surface of the thermo-couple. A suitable galvanometer is connected in series with the thermo-couple, and its deflections are proportional to the fourth power of the absolute temperature of the source.

OPTICAL PYROMETERS.—These instruments, of which several forms are in use, all have a photometric basis. They compare the intensity of the red rays from the source with the intensity of the red rays given by a standard lamp. For example, in the Holborn-Kurlbaum pyrometer the filament of an electric glow-lamp is placed in the focus of the telescope which views the source. The current through

the filament is then adjusted until the filament is of the same intensity as the source. It is now assumed that the temperatures of the source and filament are the same, and in order to standardise the instrument it is necessary to find the connection between the current through the filament and its temperature. This may be done by using several standard temperatures in an experimental furnace, the standards being the known melting-points of various pure substances. On the other hand, one could calibrate the instrument from observations on a suitably constructed air-thermometer, the bulb of which is placed in the experimental furnace.

It will be noticed that with total radiation pyrometers and with optical pyrometers the observations are taken on the interiors of enclosures, the walls of which are at practically the same temperature throughout. If such instruments are directed on to the glowing surface of a crucible of molten metal freely exposed to the laboratory, the reading for the temperature would be too low, because the radiating surface is not black, nor does it behave as black, in a radiation sense, unless it is totally enclosed in opaque walls at the same temperature.

A NEW PRINCIPLE IN OPTICAL PYROMETRY.—Paterson and Dudding recently read a paper entitled "The Estimation of High Temperatures by the Method of Colour Identity" before the Physical Society of London. In this paper the authors introduce an entirely new principle into optical pyrometry. Their method of temperature measurement is based on the physical discovery that, when a body is radiating in the open, and not in an enclosure at a uniform temperature, the colour of the light emitted (in the visible spectrum) may be identical with the colour emitted by a black body, even though the total radiation over the visible spectrum is less than that due to a black body. Such sources of light may be appropriately termed "grey," and Paterson and Dudding's method may be summarised by stating that the temperatures of "grey" bodies are identical with those of black bodies when the tint of the light is the same.

The comparison of colour is made similarly to photometric comparisons of intensity. In the practice of the method the intensity adjustment is also carried out, although no readings of the photometer bench are taken. The readings actually recorded are the values of the current in the comparison glow lamp. In order to convert these readings into temperatures it is necessary to find the temperatures of the filament by other means, as in the case of the Holborn-Kurlbaum pyrometer.

THE AEOLIAN HARP.—This instrument offers several interesting problems, which have not, up to the present, been completely solved. In general appearance it resembles the monochord of the instrument-maker, and consists of a sound box, 3-ft. long, 5-in. wide, and 3-in. deep, made of pine, with hardwood ends to hold the tuning pins and hitch pins. A dozen or so of gut strings of different thicknesses, stretched rather slackly over the bridges near each end of the sounding-board, are tuned in unison. The sounding-board is provided with two rose holes, like those of a violin. A long funnel is formed of an upper board, which rests an inch or two over the strings on projections from the hardwood ends, and of an extension laterally of the sounding-board. The harp is placed on the window-sill, and the lower sash drawn down on to the top of the funnel. With moderate wind the sounds are pleasing, but when the wind is too violent, shrill discords result.

Rayleigh has already dealt with the subject, and now returns to it in a paper entitled "Aeolian Tones" in *The Philosophical Magazine* for April, 1915. He has shown that the vibrations of the strings are transverse to the wind, and has subjected the matter to mathematical analysis. Some of the results have been further tested by experiments on motion in air and by observations on a pendulum suspended in moving water.

RADIO-ACTIVITY.

By ALEXANDER FLECK, B.Sc.

ANNUAL REPORT OF THE RADIUM INSTITUTE.—The report of the work accomplished by this institute during 1914 has just been published. The first few pages are devoted to a description of the form in which the radium is used, the screens with which it is covered, and the length of time during which the active material should be applied. A short account is also given of the results that should be looked for by different exposures to the rays, and the various factors which influence these results are also stated. The greater part of the report is, however, occupied in enumerating the various diseases which have been treated, and discussing the results obtained, with a detailed description of a large number of typical cases. The report concludes with a short account of the work of the chemico-physical laboratory of the Institute, which shows that its work is extending rapidly, and in many instances the requirements during 1914 have been three or four times as great as those of 1913.

Although the record of 1914 does not disclose any epoch-making results in the treatment and cure of malignant disease, it can at least be said that steady progress is being made in the better use and control of the energy and properties of radium.

A NEW METHOD OF RADIUM THERAPY.—A number of papers by Dr. W. C. Stevenson, of Dublin, have appeared during the past months in various medical journals describing one method which has been used in that city for the medical use of radium emanation. The essentially new feature of this method is that the radium emanation is sealed into capillary tubes of 0·76 millimetre external diameter. These tubes are then fixed with wax inside hollow needles of one millimetre external diameter, which are very similar to the needles of a hypodermic syringe. The great advantage of them is that they can be inserted into a tumour with comparatively little pain to the patient, and without the use of an anaesthetic. As fifty millecuries of emanation can be placed in one inch of the capillary tube, and as six needles can be inserted in one moderately sized tumour, it is evident that the dosage of radium can be varied at will over a large range. There is also the additional advantage that the whole of any desired region can be radiated much more uniformly than is possible with one supply placed at one point.

THORIUM CONTENT OF THE EARTH'S CRUST.—A paper is contributed by J. H. Poole to the April number of *The Philosophical Magazine* on this subject. It gives the results of the analysis (by radio-active methods) of the thorium content of a large number of acid, intermediate, and basic igneous rocks. The method employed is a comparative one, described by Joly a number of years ago, in which the activity of the short-lived emanation is measured. The results of the work are (1) The more acid an igneous rock is, the more thorium it is likely to contain; (2) the average content of a gramme of granite is $2{\cdot}05 \times 10^{-5}$ grammes of thorium, and of a gramme of basalt $0{\cdot}56 \times 10^{-5}$ grammes of thorium; (3) the mean value of the thorium content of the earth's crust is probably $1{\cdot}50 \times 10^{-5}$ grammes per gramme; and (4) there is no constant relation between the amounts of radium and thorium in igneous rocks, and consequently there is no evidence, so far as this work goes, of a genetic connection between thorium and radium.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

AN ISHMAELITE IBEX.—Dr. John C. Phillips reports on the Sinai Ibex (*Capra nubiana sinaitica*), a much persecuted species, which is found over all the rugged parts of

the Sinai Peninsula. "Every hand is against it during the entire year, and its freshly dropped kids are eagerly hunted by the natives with dogs." Its numbers are dwindling, but it still persists. Caves among the rocks are used as hiding-places. It seems to be independent of water—at least during winter and spring.

LONG-CONTINUED PARTHENOGENESIS. — Dr. A. M. Banta, working at the Cold Spring Harbour for Experimental Evolution, has reared a hundred parthenogenetic generations of *Daphnia pulex*, the common water-flea. There was no occurrence of males, and no evidence of decreased vigour or loss of vitality in the lines. Hence it appears that there is no necessary sexual cycle in the reproduction of this crustacean.

A POWERFUL TOXIN.—A mould growing on bread does not suggest an extreme of poisonousness, but that is what R. A. Gortner and A. F. Blakeslee have found to be true of *Rhizopus nigricans*, which produces a deadly toxin. The toxin has no effect when taken into the food canal by a rabbit, but it is fatal if injected into the veins, even in so small an amount as 1 to 275,000 parts of body weight. It is one of the most poisonous organic substances known.

GASTROLITH FROM A MOOSE.—It is not uncommon to find concretions in the stomach of herbivorous animals, the "hair-balls" of horses and cows being very well known. Professor D. Fraser Harris describes an interesting form from the Moose, which consisted of concentric layers of calcium phosphate around a flat, smooth piece of slate. The whole was a hard oval calculus, about two inches in length. Similar concretions have been reported with a tooth in the centre.

PREDICTION OF SEX.—It would be difficult to find a problem in regard to which there has been, and still is, quainter speculation than that of the determination of sex. There is a widespread theory in Japan that the disposition of the hairs on an infant's neck affords a basis for predicting the sex of the next child, if there is one. If the lines of hairs from the neck to the occipital region are divergent, the next child will be a boy; if the lines converge, a girl. Mawe and Perriraz have been recently inquiring whether this holds for Europe.

A ZOÖLOGIST AT THE FRONT.—Corporal Fred Vlès, a zoölogist well known for his interest in the problems of animal locomotion and for his beautiful cinematograph films of sea-urchin development, made an interesting observation on a road somewhere near the Aisne. He was bicycling slowly on a day without wind, and observed a wasp flying backwards in front of him. That is to say, the tip of the abdomen was foremost in the progression, and the head faced the observer. The wasp was attracted by traces of fruit on M. Vlès's cap, and kept up the backward flight for more than ten yards at a time. As the observer points out, the case well deserves further investigation.

NUMBER OF BRITISH BIRDS.—The British Ornithologists' Union has brought out a second and revised edition of their well-known "List of British Birds." It includes no fewer than 475 names, 99 more than there were in the first edition (1883). An appendix gives a long list of birds, whose claims to be called British have been rejected by the Editorial Committee. Of the authenticated list of 475, 188 are regular breeding birds, 286 are non-breeding, and one (the Great Auk) is extinct. There are 141 residents, 47 summer visitors, 46 winter visitors, 30 birds of passage, 61 occasional visitors (recorded more than twenty times), and 149 rare visitors (recorded on fewer than twenty occasions). That the last should be the largest category in the classification shows how diligent the search for the occurrence of rare birds has been in the British Islands.

DETERMINATION OF SEX IN PIGEONS.—Very interesting observations have been made by Dr. Oscar Riddle, who finds evidence of two different kinds of eggs in pigeons. Those destined to produce males are smaller, and have higher water-content and smaller energy-content than those that will produce females. By means of the bomb calorimeter he has been able to demonstrate that eggs destined to become males contain less stored energy than eggs destined to develop into females. We are referring to a preliminary notice of Dr. Riddle's work, and we presume that the account of his observations will explain how it is known that an egg is destined to become a male or a female until it does. We note, however, that the investigator is quite clear that the difference in energy-content may be an effect of sex-determination, and not the cause.

BLIND TACTICS.—How can one explain the well-known fact that many an insect-mother is careful to secure the welfare of her offspring which she never sees? She lays her eggs in appropriate places, often very difficult to get at; she surrounds them with food-materials; she often collects a living larder of paralysed creatures to satisfy their juvenile appetite. Yet she is dead and gone before her offspring are hatched! There is no doubt that we have here to deal with one of the greater problems of biology, and one that has not been seriously tackled. How can a creature work sedulously, intricately, persistently towards an end which is unknown, which cannot be pictured, because never experienced? We would, in the meantime, suggest that part of the puzzle may disappear if we assume that the ancestors of the insects in question did survive to see their offspring. It may be that the routine now instinctive—that is to say, hereditarily entailed—was established among ancestral forms that did survive to see the reward of their labours. The dim meaningfulness of to-day may be an echo of a clearer significance in ages long since past.

LONG PEDIGREE OF SLIPPER ANIMALCULES MULTIPLYING ASEXUALLY.—We have already referred in these Notes to the continuous generations of *Paramecium aurelia* which have been observed in the Yale Zoölogical Laboratory by Professor L. L. Woodruff. In November, 1914, the race had existed for seven years and four thousand five hundred generations, and remained quite normal, though there is no conjugation. In a study by Woodruff and Rhoda Erdmann attention is directed to a very interesting occurrence which they call "endomixis." At frequent intervals the old nuclear apparatus breaks down, as if conjugation were going to occur, and a reorganisation is effected, which initiates a period of new metabolic activity, and therefore of reproductive activity. It occurs on an average about once a month. It may afford a field for the origin of variations. It is an internal regulatory phenomenon which is self-sufficient for the indefinite life of the race in a favourable environment. This is obviously an idea of great interest.

MEMORY OF COCKROACH.—Dr. F. Bretschneider kept Cockroaches in a breeding-cage, and fed them in an adjoining experimental cage, the communication between the two being through an aperture which could be closed. The feeding-cage had a glass floor, which was cleaned every day, and the cage was divided into two chambers by a partition with six apertures, which could be closed and opened. The food was placed in the chambers farthest from the dwelling-cage. A lateral opening in the partition-wall was opened to begin with, and the insects got accustomed to use it. After a time it was closed, and one at the other side was opened. But the insects continued to try the closed door, which shows a local memory. There could be no scent, as the glass floor was washed every day. Szymanski showed in 1912 that Cockroaches could be taught to prefer the light half of a cage to the dark half, which is contrary to their nature, by arranging that those who went into the dark half got a mild electric shock. They soon learnt and soon forgot again, but they took a shorter time to learn the second time. The seat of memory is almost certainly in the mushroom-shaped bodies on the anterior surface of the protocerebrum.

THE FACE OF THE SKY FOR JUNE.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 25.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Mars. R.A.	Mars. Dec.	Jupiter. R.A.	Jupiter. Dec.	Uranus. R.A.	Uranus. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
June 5	4 49·4	N.22·5	23 30·6	S. 0·6	6 27·8	N.24·3	3 1·1	N.15·5	2 22·4	N.13·4	23 45·5	S. 2·8	21 15·0	S.16·8	8 2·2	N.20·1
,, 10	5 10·1	23·0	3 19·1	N.23·5	6 38·1	23·1	3 25·2	17·3	2 36·8	14·0	23 47·8	2·6	21 12·7	16·8	8 2·9	20·1
,, 15	5 30·8	23·3	7 42·1	N.23·6	6 40·0	21·8	3 49·8	18·8	2 51·2	15·8	23 49·8	2·4	21 12·4	16·9	8 3·5	20·1
,, 20	5 51·6	23·4	11 43·2	S. 1·7	6 34·3	20·5	4 14·9	20·1	3 5·7	16·8	23 51·6	2·2	21 12·0	16·9	8 4·2	20·1
,, 25	6 12·4	23·4	16 25·7	S. 26·5	6 23·1	19·4	4 40·3	21·3	3 20·2	17·8	23 53·2	2·1	21 11·5	17·0	8 4·9	20·0
,, 30	6 33·1	N.23.2	21 38·7	S. 13·6	6 10·9	N.18·8	5 0·2	N.22·2	3 34·8	N.18·8	23 54·4	S. 2·0	21 10·9	S.17·0	8 5·6	N.20·0

TABLE 26.

Date.	Greenwich Noon. Sun. P	Sun. B	Sun. L	Greenwich Midnight. Moon. P		Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
	°	°	°	°		°	°	°	°	h. m.	h. m.
June 5	− 14·2	−0·1	206·4	−22·3							
,, 10	12·2	+0·5	140·2	−13·1	June 5	−25·4	+1·9	252·9	123·9	5 4 *c*	8 34 *c*
,, 15	10·1	1·1	74·0	+10·7	,, 12	25·5	1·9	277·9	95·5	4 23 *c*	9 21 *c*
,, 20	7·9	1·7	7·8	+22·4	,, 19	25·5	2·0	303·0	67·2	3 42 *c*	10 8 *c*
,, 25	5·7	2·3	301·7	+ 6·7	,, 26	−25·5	+2·0	328·3	39·1	3 0 *c*	10 54 *c*
,, 30	− 3·4	+2·8	235·5	−18·9							

P is the position angle of the North end of the body's axis measured eastward from the North point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Jupiter System I refers to the rapidly rotating equatorial zone, System II to the temperate zones, which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1 T_2 multiples of $9^h\ 50^m{\cdot}5$, $9^h\ 55^m{\cdot}7$ respectively.

The data for the Moon and Planets in the Second Table are now given for Greenwich Midnight, *i.e.*, the Midnight at the end of the given day.

The letters *m*, *c* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN is moving Northwards till the 22nd, when it reaches the Summer Solstice and commences to move Southward. Its semi-diameter diminishes from 15′ 48″ to 15′ 45″. Sunrise changes from $3^h\ 51^m$ to $3^h\ 49^m$; sunset from $8^h\ 4^m$ to $8^h\ 18^m$. The Sun's surface is likely to repay careful scrutiny, owing to the recrudescence of activity.

MERCURY is an evening star, till June 27th. East Elongation, 23° from Sun, on May 31st. Semi-diameter increases from 4″ to 6″. Illumination diminishes from $\frac{3}{8}$ to Zero.

VENUS is a morning star. Illumination over nine tenths. Semi-diameter diminishes from 6″ to 5¼″.

THE MOON.—Last quarter $4^d\ 4^h\ 32^m$ *c*. New $12^d\ 6^h\ 57^m$ *c*. First quarter $20^d\ 2^h\ 24^m$ *c*. Full $27^d\ 4^h\ 27^m$ *m*. Apogee $11^d\ 1^h$ *m*. Perigee $26^d\ 2^h$ *m*, semi-diameter 14′ 43″, 16′ 40″ respectively. Maximum librations 3^d 8° W., 10^d 7° S., 19^d 7° E., 24^d 7° N. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon (see Table 27).

MARS is still badly placed, but may be observed as a morning star. Semi-diameter 2¾″.

JUPITER is a morning star, in Pisces; in quadrature with the Sun on 19th. Equatorial diameter 39″, Polar 37″.

Configurations of satellites at 2^h *m*.

JUPITER'S SATELLITES.

Day.	West.		East.		Day.	West.		East.	
June 1	24	⊙	3		June 16	42	⊙	3	
,, 2	2	○	134		,, 17	431	○	2	
,, 3	31	○	24		,, 18	3	⊙	12	
,, 4	3	○	14		,, 19	321	○	4	
,, 5	321	○	4		,, 20	23	○	14	
,, 6		○	314	2●	,, 21	1	○	234	
,, 7	1	○	234		,, 22		○	2134	
,, 8	2	○	134		,, 23	21	○	34	
,, 9	2	○	34	1●	,, 24	3	○	24	1●
,, 10	31	○	2		,, 25	3	○	124	
,, 11	34	○	12		,, 26	321	○	4	
,, 12	4321	○			,, 27	23	○	1	
,, 13	42	○	1	3●	,, 28	41	○	23	
,, 14	41	○	23		,, 29	4	○	213	
,, 15	4	⊙	13		,, 30	421	○	3	

The following satellite phenomena are visible at Greenwich, all in the morning hours:—$1^d\ 1^h\ 52^m$ I. Sh. E., $3^h\ 12^m$ I. Tr. E; $2^d\ 3^h\ 24^m$ III. Sh. E.; $6^d\ 1^h\ 28^m\ 19^s$ II. Ec. D.; $8^d\ 1^h\ 22^m$ II. Tr. E., $1^h\ 27^m$ I. Sh. I., $2^h\ 50^m$ I. Tr. I.; $9^d\ 2^h\ 17^m$ I. Oc. R., $2^h\ 32^m$ IV. Sh. I.; $13^d\ 2^h\ 52^m$ III. Oc. R.; $15^d\ 1^h\ 10^m$ II. Tr. I., $1^h\ 13^m$ II. Sh. E., $3^h\ 21^m$ I. Sh. I; $16^d\ 0^h\ 33^m\ 23^s$ I. Ec. D.; $17^d\ 1^h\ 30^m$ I. Tr. E.; $18^d\ 2^h\ 43^m$ IV. Oc. R.; $20^d\ 1^h\ 19^m\ 58^s$ III. Ec. R.; $22^d\ 0^h\ 57^m$ II. Sh. I.; $23^d\ 2^h\ 27^m\ 33^s$ I. Ec. D; $24^d\ 1^h\ 6^m$ I. Tr. I., $1^h\ 27^m$ II. Oc. R., $2^h\ 1^m$ I. Sh. E., $3^h\ 24^m$ I. Tr. E.; $25^d\ 0^h\ 34^m$ I. Oc. R.;

$26^d\ 0^h\ 41^m$ IV. Sh. E.; $27^d\ 2^h\ 12^m\ 48^s$ III. Ec. D.; $29^d\ 3^h\ 34^m$ II. Sh. I.

SATURN is invisible, being in conjunction with the Sun on 28th.

URANUS is a morning star, but badly placed.

NEPTUNE is an evening star in Cancer; diameter 2″.

DOUBLE STARS AND CLUSTERS.—The tables of these, given three years ago, are again available, and readers are referred to the corresponding month of three years ago.

VARIABLE STARS.—Stars reaching their maxima in or near June, 1915, are included. The lists in recent months may also be consulted (see Table 28).

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
	°	°	
May 30 to Aug	333	+ 28	Swift, streaks.
May—June ...	280	+ 32	Swift.
May July ...	252	− 21	Slow, trains.
June—Aug. ..	310	+ 61	Swift, streaks.
,, —Sept. ..	335	+ 57	Swift.
,, —July ..	245	+ 64	Swift.
,, —Aug. ..	303	+ 24	Swift.

TABLE 27. Occultations of Stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Time.	Disappearance. Angle from N. to E.	Reappearance. Time.	Reappearance. Angle from N. to E.
1915.			h. m.	°	h. m.	°
June 1 ...	BAC 6814	6·3	2 49 *m*	58	4 1 *m*	259
,, 3 ...	44 Capricorni	6·0	1 23 *m*	41	2 29 *m*	265
,, 16 ...	BAC 3029...	Var.	9 25 *e*	113	10 18 *e*	294
,, 16 ...	BD+17° 1979	6·8	10 11 *e*	92	—	—
,, 18 ...	WZC 696	7·4	9 21 *e*	61	—	—
,, 21 ...	BD − 10°·3570	6·0	8 43 *e*	151	9 44 *e*	271
,, 21 ...	BD − 11°·3398	6·7	10 26 *e*	151	—	—
,, 24 ...	4 Scorpii	5·6	11 19 *e*	41	11 56 *e*	337
,, 25 ...	WZC 1098	6·7	11 54 *e*	141	—	—
,, 26 ...	BAC 6127	4·7	9 34 *e*	152	10 7*e*	206
,, 27 ...	BAC 6562	5·9	—	—	9 26 *e*	325
,, 29 ...	WZC 1359	6·8	—	—	4 37 *m*	299
,, 29 ...	BD − 17°·6216	6·2	—	—	10 38 *e*	232

From New to Full disappearances occur at the Dark Limb, from Full to New reäppearances.

TABLE 28. LONG-PERIOD VARIABLE STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m. s.	° ′		d.	
R Andromedae	0 19 33	+38 6	5·6 to 14·0	411	1915—May 29
RX Cephei	0 43 9	+81 30	7·4 to 7·9	130	,, June 1
X Camelop.	4 34 29	+74 58	7·3 to 13·1	142	,, July 1
R Corvi	12 15 13	−18 47	5·9 to 12·9	318	,, June 26
R Camelop.	14 23 35	+84 13	7·2 to 13·3	270	,, July 11
S Ursae Min.	15 32 47	+78 55	7·2 to 11·6	323	,, June 20
S Herculis	16 48 2	+15 15	5·9 to 13·1	308	,, July 21
R Ophiuchi	17 2 53	−15 59	6·0 to 13·6	302	,, June 20
R Cygni	19 34 33	+50 0	5·9 to 13·8	426	,, June 28

Night Minima of Algol $10^d\ 3^h\cdot8\ m$, $13^d\ 0^h\cdot6\ m$, $15^d\ 9^h\cdot4\ c$, $30^d\ 5^h\cdot5\ m$. Period $2^d\ 20^h\ 48^m\cdot9$.

Principal Minima of β Lyrae $13^d\ 3^h\ m$, $26^d\ 1^h\ m$. Period $12^d\ 21^h\ 47^m\cdot5$.

REVIEWS.

CHEMISTRY.

Quantitative Organic Analysis.—By P. C. R. KINGSCOTT, B.Sc., A.I.C., and R. S. G. KNIGHT, B.Sc., A.I.C. 283 pages. 51 figures. 8½-in. × 5¾-in.

(Longmans, Green & Co. Price 6/6 net.)

The analysis of organic compounds does not admit of that degree of systematisation which has been found possible in the case of inorganic compounds. Group reägents can only be used to a limited extent for the separation of carbon compounds into separate classes; and, in examining an unknown compound, it is necessary to determine its elementary composition, molecular weight, and physical properties, as well as to ascertain the presence of distinctive groups of atoms within its molecule. The object of this book has been to give a concise, workable description of all the methods commonly employed; and, since many of the processes for the estimation of special radicles are not readily accessible, the authors have done a serviceable work in bringing them together in a convenient form. The

book will therefore be found of great use both to the student and to the chemist in practice; and its value is enhanced by the inclusion of the methods applicable to compounds of technical importance, such as sugars, dyestuffs, alcohols, and oils. Diagrams of apparatus are supplied where necessary, and full references to the original papers are given in each case. As a rule, the working directions are quite clear, though occasionally—as in the description of the bromine absorption method—further detail would be desirable. The most noticeable error is the omission of the final "s" from the name "Wijs," which does not appear to be a misprint, since it is repeated in another place.

C. A. M.

GEOGRAPHY.

The Home of Man. Part III. America.—By W. C. BROWN and P. H. JOHNSON. 282 pages. 107 illustrations. 7½-in. by 5-in.

(George G. Harrap & Co. Price 1/9 net.)

Part IV. Asia.—By L. A. COLES. 192 pages. 91 Illustrations. 7½-in. × 5-in.

(George G. Harrap & Co. Price 1/3 net.)

Although a large number of school geographies has been published in recent years, these volumes, which are included in "The New Outlook Geography" series, should prove very useful to teachers. The various parts of the world are examined, from the "human" standpoint, in preference to the purely scientific, and emphasis is laid throughout on the relations between population and physical conditions, the methods being statistical rather than descriptive. The books are well illustrated by a large number of maps and diagrams, and numerous questions and exercises are interspersed throughout the text. In Part III the geology of Central America, as shown in Figure 10, differs radically from that given in Figure 70, while the "annual rainfall" maps of the same countries (Figures 20 and 69) likewise do not agree. Each volume has a useful index and also an appendix containing tables of trade and other data. The lack of uniformity in the units employed in the latter is somewhat confusing, while some of the figures are scarcely the most recent.

A. S.

ORNITHOLOGY.

Field Studies of Some Rarer British Birds.—By JOHN WALPOLE-BOND. 305 pages. 9-in. × 5¾-in.

(Witherby & Co. Price 7/6 net.)

A love of birds and the desire to protect the rarer ones from extinction are now very widely spread, and many will be glad to have in collected and revised form the personal observations of Mr. Walpole-Bond upon some of the British species, which cannot be called common, although in his preface he gives the pleasing information that most rare birds are considered rarer than they are in reality. We might expect that Mr. Walpole-Bond would have something to say of choughs and ravens, eagles, buzzards, and kites, not to mention the peregrine falcon; and this is the case; but he also gives us an account of Dartford warblers, crossbills in Sussex, and cirl-buntings in the same county. The woodlark, we are told, is much more local than would be gathered from many books on British birds, and Mr. Walpole-Bond says that in very many places it is one of extremely rare occurrence, at any rate as a breeding species. The pied-flycatcher, as studied in its Welsh resorts, is another bird that is dealt with. The nest is sometimes a joint-stock affair. Eggs of the redstart have been found in it, and several kinds of tits have helped to rear a mixed brood. The usurping and eviction on the part of other small hole-breeders does not, of course, says Mr. Walpole-Bond, take origin from any love those birds may have towards the pied-flycatcher. It is simply owing to the fact that in some districts there are not enough suitable holes to go round. We know that in one locality in Wales the pied-flycatcher takes readily to nesting-boxes, and comes back to them year after year with hardly the difference of a day. Therefore there is an opportunity for bird-lovers to attract and protect this species.

W. M. W.

THE SEA.

Nature Notes for Ocean Voyagers.—By CAPTAIN A. CARPENTER, R.N., D.S.O., and CAPTAIN D. WILSON-BARKER, R.N.R. 181 pages. 139 illustrations. 9-in × 6½-in.

(Charles Griffin & Co. Price 5/- net.)

There are many who have to travel on the sea who, although they have no scientific knowledge of the phenomena and creatures with which they may meet, at the same time are thoroughly interested in them, and are desirous of knowing something about their unfamiliar surroundings. For these, Captains Carpenter and Wilson-Barker have written the attractive book under consideration. Physical features of the ocean are not forgotten. Natural history, as may be expected, comes in for considerable attention, and this includes surface life and ocean deposits. Even old sea monsters are dealt with, and there are chapters on Weather and on Waves. Among the illustrations to these are some of the photographs of clouds and of ripples, for which Captain Wilson-Barker is famous. Not the least interesting is the final chapter on "Some Old Sea Customs and Chanteys."

W. M. W.

ZOÖLOGY.

An Introduction to the Study of Fossils.—By HERVEY WOODBURN SHIMER, A.M., PH.D. 450 pages, 175 figures. 7¾-in × 5-in.

(Macmillan & Co. Price 10/6 net.)

Even nowadays there is still a tendency to keep fossil creatures distinct from living ones, and in writing this "Introduction to the Study of Fossils," Professor Shimer has had in view the students who come to him with little previous training in biology. His idea is to awake an interest in the fossils—which are too often looked upon merely as bits of stone—as once living animals and plants, connected by the wonderful chain of evolution, with animals and plants now living. Special emphasis has been laid on the relation of the soft body to the hard skeleton or shell, so that the student may reconstruct from the hard parts preserved in the rocks the appearance of the once living animal. Briefly the various classes and orders of plants and animals are reviewed, and, after most of the paragraphs, instructions and questions are printed for the benefit of students. The descriptions are necessarily short, but they are quite sufficient to fulfil the objects of the author, and to give the student a very fair idea of the animal and vegetable kingdoms.

W. M. W.

Some Minute Animal Parasites.—By H. B. FANTHAM, D.Sc., and ANNIE PORTER, D.Sc. 319 pages. 58 illustrations. 7½-in. × 5-in.

(Methuen & Co. Price 5/- net.)

The importance of the work in zoölogy, or perhaps we had better say proto-zoölogy, which is now being done in connection with the investigation of diseases is possibly not realised by the general public. Articles in magazines and exhibits at scientific conversaziones have familiarised people with the blood parasites causing malaria and sleeping-sickness; but it needs a popular book, such as the one by Doctors Fantham and Porter, to make generally known the many "unseen foes in the animal world" which have been discovered or unmasked during recent years. Not only are the diseases to which we have alluded considered in detail, but similar ones which attack animals, other than man. Spirochaetes, which the authors have themselves specially investigated, which are found in many animals, come in for attention. Oysters and mussels are troubled with them, while those which cause African tick and other fevers live in the mites known as "ticks," and are transmitted by them to man. Coccidiosis is a disease which plays havoc in the poultry yard and on the grouse moor. The parasites which cause it live in the alimentary canal, and enormous numbers of them reduce the lining to a structureless pulp, with a fatal result. Harmless and harmful amoebae, the diseases of yellow fever and red water, bee and silkworm diseases, and many others are simply described in "Some Minute Animal Parasites."

W. M. W.

NOTICES.

MR. RICHARD LYDEKKER, F.R.S.—We are very sorry to record the death of Mr. Richard Lydekker, a distinguished contributor to "KNOWLEDGE," and well known for his work in Geology and Zoölogy.

ECONOMIC BOTANY.—Messrs. John Wheldon & Company's catalogue (No. 69) contains the titles of some hundreds of books and papers dealing with commercial plants, cotton, dyeing, weaving, brewing, as well as grasses, sugar, timber, forestry, and tobacco.

MRS. HENRY DRAPER.—We have received a reprint of an article by Miss Annie J. Cannon, from *Science*, giving an interesting account of the life of the late Mrs. Henry Draper, who, in the same way as Lady Huggins helped Sir William Huggins, was an enthusiastic and capable co-worker in astronomy with her husband, the late Dr. Henry Draper.

RUSSIAN EQUIVALENT TABLES.—In view of the increasing importance of trade with Russia, the Central Translators' Institute, of 265 Strand, has compiled a set of tables, dealing with the somewhat complicated Russian weights and measures, which permit of the instant conversion of British weights, measures, and money into Russian, and *vice versa*, and cover all ordinary commercial requirements. The price is one shilling.

MICROSCOPE MATERIALS.—We have received from Mr. C. Baker his catalogue of microscope materials. It contains details of stains and reägents, bacteriological and other apparatus, mounting sundries, pond-life apparatus, and mounted specimens. We notice that, in common with other manufacturers, Mr. Baker has had to advance his prices somewhat where metal and glass are concerned, and also in the case of stains.

VILLAGE INDUSTRIES.—Some of the few village industries which survive are exceedingly interesting. They could be made most helpful to rural workers, and it should be possible to revive and introduce others. We hope, therefore, that the National Council of Toy Industries, which has been formed, will be able to encourage work which can be done in cottage homes. The Secretaries may be addressed at 33, Buckingham Mansions, N.W.

PROFESSOR HERDMAN.—Arrangements have been made for the portrait of Professor Herdman, painted by Robert Duddingstone Herdman, to be reproduced by heliogravure process, and issued to subscribers. The cost will not exceed ten shillings; and if one hundred applicants subscribe, it will be but five. Any proceeds, after the payment for the plate and reprints, will be devoted to Belgian refugee artists. Particulars may be obtained from Miss May Allen, Zoölogical Library, The University, Liverpool.

THE LATE PROFESSOR TARRIDA DEL MARMOL.—An appeal is being made for the widow and children of the late Professor Tarrida del Marmol, who was born in Santiago, in Cuba, in 1861, of a distinguished Spanish family. In his boyhood he showed a marked talent for mathematics, and, later, turned to astronomy. He devoted his pen and his purse to every forward movement, from constitutional liberalism to philosophic anarchism. The address of the Secretary of the Marmol Committee is 92, Selwyn Avenue, Highams Park, London, N.E.

MR. MURRAY'S QUARTERLY LIST.—Among Mr. Murray's new and forthcoming works are several dealing with the war. Dr. Chalmers Mitchell is responsible for one on "Evolution and the War"; Mr. Theodore Andrea Cook contributes a series of essays on "Kaiser, Krupp, and Kultur"; while Professor Muirhead discusses "German Philosophy and Its Relation to the War." Volumes III and IV of "The Arts in Early England," by Professor Baldwin Brown, which will deal with Anglo-Saxon art and industry in the pagan period, are now promised.

ROAD CONSTRUCTION.—In a paper read recently before the Society of Engineers Mr. Frank Grove, the Assistant Surveyor of the County of Surrey, summarised the development of roads in England from the time of the Roman occupation, and referred in greater detail to those of more recent times. He described the nuisance arising from dust, the extensive damage done to road surfaces, and the means taken to minimise these troubles. He then gave an account of the maintenance of the roads in the County of Surrey, which were more used by motor-cars than those of any county around London; and, finally, he described the methods of construction of the various types of roads now used.

BRITISH ANTS.—Messrs. William Brendon & Sons announce the publication, at one guinea, of a work on "British Ants," by Mr. Horace Donisthorpe, provided the number of copies subscribed for be sufficient to make production possible. Hitherto the study of British ants has been greatly hindered by the lack of a book giving the classification and descriptions of all the species known to occur in these islands. Mr. Donisthorpe has been at work for many years on a work which is expected to consist of three hundred and fifty pages, seventy figures, and forty photographs. From the specimen pages it would appear that great care has been exercised in the preparation of the book, and that it will contain interesting details as to habits and life-history. The book is quite ready to go to press, but the difficulties occasioned by the War have caused the author to postpone the printing of it until a fuller list of subscribers has been obtained. Messrs. Brendon & Sons' address is Plymouth.

ALCHEMY AND PHALLICISM.—At the last meeting of the Alchemical Society the acting president, Mr. Stanley Redgrove, B.Sc., read a paper on "The Phallic Element in Alchemical Doctrine." The lecturer brought forward further evidence in support of his theory that the doctrines of the mediaeval alchemists originated in an attempt to apply, by means of analogy, the accepted religious dogmas concerning the soul and its destiny to chemical and physical phenomena. A further source of *a priori* reasoning was, the lecturer said, to be found in the rudimentary physiology of the period. It was natural for primitive man to attempt to explain the universe anthropomorphically, and this led to his attributing sex, not only to the world as a whole, but to inanimate objects. This gave rise to "phallicism," or the worship of sex; and so far as the alchemists were concerned, what the lecturer called "the phallic element in alchemical doctrine" manifested itself in a belief that the metals propagated themselves sexually.

BIOLOGY AND THE WAR.—No. 24 of "Papers for War-time" is by Professor J. Arthur Thomson, and deals with "Biology and the War." The author points out that the struggle for existence does not necessarily make for evolution, and in many cases thins out without sifting. From a biological point of view war must be regarded with anxiety, since it impoverishes the race, through the death of a disproportionately large number of those whom we can at least afford to lose, and that, far from being in full accordance with Nature's message to man, it is a reversion to the crudest and most primitive form of the struggle for existence. In conclusion, Professor Thomson asks if this war brings racial impoverishment, as it seems bound to do, what counteractives are possible? He thinks that we may look for a more marked disapproval of selfish forms of celibacy and a stronger encouragement of chivalrous marriages. There may spring up a freshened enthusiasm for all-round fitness and a high standard of health. With regard to retrenchments, he goes on to say: "To economise upon the nobler super-necessaries means crippling such supermen as painters and musicians. May we not try pinching ourselves in our comforts before we begin starving our souls?" What the biologist is most concerned with is the natural inheritance of the race; but if this is impoverished it rests with us, each in his own way, to try to secure that our social heritage may be enriched.

CROSS & COLE'S Modern Microscopy. A Handbook for Beginners and Students, with chapters on special subjects by various writers. Fourth Edition, revised and enlarged. Demy 8vo. Pp. xviii–426, with 113 plates and other illustrations. Price **6s.** net.

MUTER'S Analytical Chemistry. Qualitative and Quantitative, Inorganic and Organic. Edited by J. THOMAS, B.Sc. Tenth Edition. Thoroughly revised in accordance with the New Pharmacopœia. 252 pp. 56 illustrations. **6s.** net.

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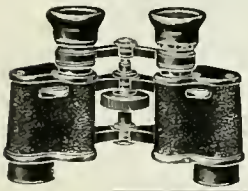

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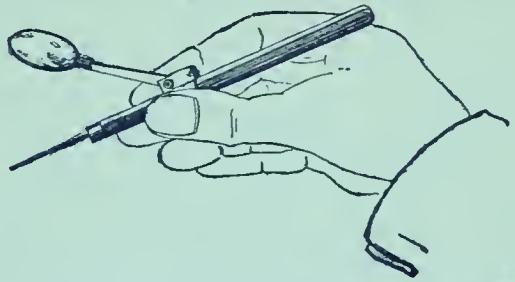

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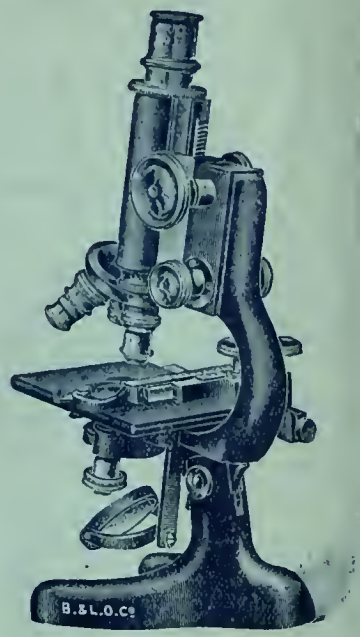

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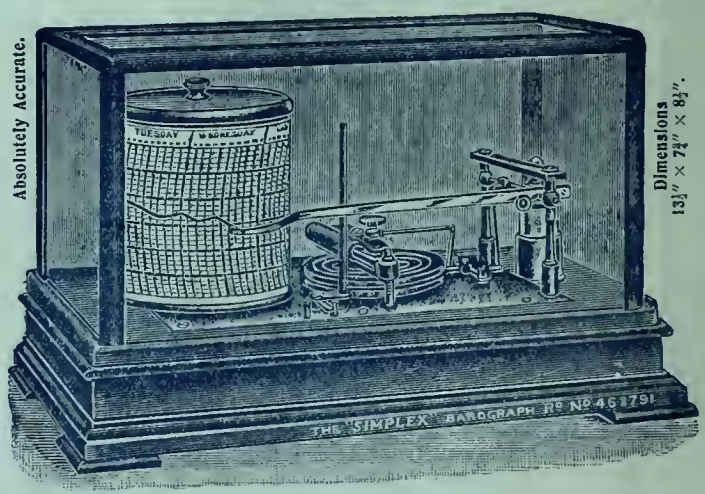

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